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FUNGI AND PLANT DISEASES.

[*Contributed.*]

Of recent years there has been a decided tendency to exaggerate the importance of fungi and to regard them as being the primary cause of most plant diseases. It is believed that this point of view has at once obscured the real causes of many diseases and delayed the application of effective remedial and preventive measures, inasmuch as vital factors, such as soil-moisture-content and soil-aeration, are frequently easier to control on a large scale, both in agriculture and forestry than are injurious fungi. This opinion has been already expressed in our Indian forest literature,* but it is especially interesting to see that Mr. Massee, the well-known English Mycologist, writes on this question as follows in the *Kew Bulletin* for 1913 (pp. 343—345):—

"A quarter of a century ago, with a few notable exceptions, such as rust of wheat, etc., fungi were not credited with being active agents in causing injury to plants; at the present day the

* *Ind. For. Mem. Bot.*, Vol. I, pp. 31, 32.
Ind. For. Rec., Vol. V, 4, pp. 38, 39.

pendulum has swung to the opposite extreme, and fungi are gravely suspected as being the cause of almost every important disease attacking plants of economic value. Epidemics caused by fungi among wild plants in a state of nature are practically unknown. It will, I believe, be generally admitted that plants cultivated under glass are much more susceptible to attacks from fungi than when the same kinds of plants are grown out of doors, in fact I usually fail to infect plants growing in the open with spores obtained from the same kinds suffering from an epidemic when grown under glass. A good deal of evidence could be given on the same lines, to show that fungi are not so much to blame as is usually supposed for being the primary cause of plant diseases. Experience has proved that fungi undoubtedly are the cause of an enormous loss to cultivators of plants, either as primary or secondary agents, and as the injury caused by the fungus is much more obvious than that produced by the primary cause, it is usually concluded that the injury is entirely due to the fungus, whereas in reality but for the road being made clear by the primary agent, the fungus, which completes the work of destruction, could not have gained a foothold. For the above reasons I am led to consider that attention to fungi alone is but a poor equipment for a post as plant pathologist, and will not lead to a reduction of the losses caused indirectly by fungi, which can never be exterminated."

*   *   *   *

"The principal reason why there are no epidemics due to fungi in virgin forests and uncultivated places is because host and parasite have lived together for an indefinite period of time, and by a process of elimination the survivors are able to live side by side without either being capable of exercising any very marked superiority."

THE TALI-POT PALM (*CORYPHA UMBRACULIFERA*).

BY G. S. BUTTERWORTH, I.F.S.

Very few Officers of the Forest Department can have ever seen this magnificent palm, fewer still must they be who know its manifold uses. *Corypha umbraculifera* is indigenous in the Andamans and in the moist forests of Honawar taluka between the river Shirawati and the Kumta taluka. While engaged on the demarcation of the Bombay-Mysore frontier, a considerable area, supporting these palms, has been found to the south of the river Shirawati and adjoining the Mysore boundary. It is found cultivated in Ceylon and Burma. To give a botanical description would not convey the beauty of this palm. The full-grown palm is tall and stout, the lower three feet of its stem increases in girth to its base. Its height is about 50 feet to the first leaf, the upper one-third of the stem gradually increases in girth to the first leaf. The stem is markedly annulate. The number of leaves are about 30. These leaves are of immense size, orbicular and split up (flabellately multifid). The leaf petiole has short sharp spines. The tree when it seeds produces them in thousands, after seeding it dies. The seeds are hard horny balls about the size of a cherry.

The uses of the tree are many and interesting. The tree when full grown is cut down and the edible pith extracted. About 2,000 are taken from the forest yearly, the majority are sold on permit at Rs. 4 per tree, two years ago the price was Rs. 2. People come from all parts of the coast south of Kumta for a tree. The pith is even taken as far as Kundapur about forty miles from the Tali forest. The trees are cut by the permit-holder and his coolies at about 4 feet from the ground; some years ago they used to erect a platform and cut it 6 or more feet from the ground, but this method which was not for the good of the forest was stopped. Having felled the tree they proceed to take off the upper half of the bark and so expose the pith. The pith does not run from the base of the tree to the crown, it starts about 10 feet from the base. Where the pith starts it is very fibrous, the quality gets better higher up the stem. The men getting out the pith cut it into long strips of roughly 7 feet and 1″ square, this is removed

from the jungle and spread out to dry; in the process of cutting the pith there is very little waste, as the coolies work very neatly and pick up all the small bits. An average tree yields about 30 headloads pith and three sacks of chips. When freshly cut the pith is damp and the flour can be seen in small lumps and strings adhering to the fibrous tissue of the pith. Much of it is taken out on headloads and a good deal by dug-outs; these dug-outs are very often overloaded and upset; the immersion into the water spoils the flour, as the river is tidal. The flour is not beaten out in the jungle, as the pith takes a good time to dry. All the Kumri Mahrattas of Honawar and Bhatkal talukas are allowed free trees. They take on an average about 200 a year, but are wasteful in the cutting. A tree does not produce its full quantity of pith until the upper one-third portion begins to swell. It is not easy, unless well acquainted with these trees, to tell which are ripe for the axe and which not. This enlargement of the stem must be due to the storing up of the starch and other materials against the trees' seed-bearing. The flour from the pith is very fine, a yellowish brown colour, and has rather a woodeny taste. It is made into cakes and is chiefly eaten by the poorer castes of people. The amount of flour from one tree must suffice a family for four months.

Another of its uses is the making of "Gulal." This "Gulal" is manufactured by mixing the dried flour with German red-lead. It is exported to Bombay and Kathiawar and is much used in Mahomedan wedding ceremonies, taking the place of rice and confetti used in England. The manufacture of this is done by Basrur Bros. of Honawar town, who take 200 trees annually; they have made a very good thing out of it as they have completely undersold the "Gulal" manufactured from roots.

The leaves of the tree were formerly used for writing upon and are now used for thatching and umbrellas. The leaves used for the last two purposes are not those of the grown trees, but are cut from the plant before it has formed a stem, from what I consider to be the 15-year old palm. For umbrellas one or two leaves are placed green over a light frame and fastened down at the edge and a stick in the middle forms a handle.

The seeds used to be carved into necklaces and buttons and were exported to the Persian Gulf. This export is not now carried on; they are still made into buttons, and carved seeds can be bought, but there is no trade in the articles.

The base of the Tali palm tree is often asked for making drums. After the tree has died or is cut down, the soft part in the base rots and leaves a deep cup-shaped hollow; this is covered with a goat's hide and so makes a drum.

There is a Tali palm growing near the Range Office in Honawar in a cocoanut garden. The owner of this tree finds that bats live under the protection of the large leaves. When the Undi fruit (*Calophyllum Inophyllum*) is ripe the bats bring large quantities back to the tree, eat the fruit and drop the hard drupes. These drupes the owner of the tree collects daily and extracts the oil which is prized on the coast. With a view to this inexpensive way of getting oil some Halipaiks of Murdeshwar and Manki are actually growing the tree.

There used to be considerable doubt as to the length of time the seed required to germinate, the prevailing idea being that it was a year or more. This doubt was set at rest by Mr. Tuggerse, at one time a Ranger in Honawar. He sowed in April and covered with earth, leaving them thus until May when he watered once or twice, mango showers supplied more water and the seeds germinated in June.

The present working-plan is based largely on conjecture as to the age when a Tali tree flowers. When the plan was made no scientific data were forthcoming. It was known, however, that certain areas had been "kumried" in certain years, on some of these mature palms were found growing and on this period the working-plan was based. The question at what age a Tali palm flowers has to be fixed with a view to finding this out.

With a view to finding this out, the following experiments have been carried out since 1910: Small sample plots have been laid out and include II, III, IV and seedling class of palms. II class are big mature trees, III class are those which have formed a stem and IV class are those which are beyond the seedling stage,

but have not yet formed a stem. The number of living leaves and of new leaves put on, are counted twice a year, and in the case of II and III class the rings counted and the height from the ground to as far as rings can be counted is taken. Until it is known what period it takes for a seedling to grow to a III class palm it will be impossible to tell the age when maturity is reached. One is told that if you know the number of rings and how many new leaves are put on in a year one can estimate the age. This is true to a certain extent, but seedling and IV class palms have no stem above ground and a leaf scar 1½ inches broad is not going to show when the tree is III class.

During the four years that the data have been collected the indications are that it takes nine years for a seedling to pass to the IV class.

It cannot be said what period is taken for a IV class to pass over to a III class, some palms originally put in the IV class are now III class, but it is not known what age they were when first classified. Personally I should say this class takes fifteen years, but personal ideas are not data.

After this the trees have rings and it should be possible knowing the number of new leaves put on on an average per year to estimate the age. The indications at present are that a III and IV class tree puts on 5 new leaves in two years. From this we get a II class tree with 160 rings has taken 64 years, and adding the time it took to reach III class it seems that a palm very near the flowering age is, say, 88 years old.

ONE YEAR'S METEOROLOGICAL OBSERVATIONS AT CHANGA-MANGA.

By R. N. Parker, I.F.S.

A meteorological observing station has been started at Changa-Manga at the instance of Sir Louie Dane, late Lieutenant-Governor of the Punjab, who when staying at Changa-Manga was shown some figures of temperature which had been recorded by the Forest Ranger, Lala Ram Nath, for his own information.

These figures seemed to show that the plantation had a considerable effect in reducing the maximum temperature, but as they were taken in the verandah of the forest rest-house they could not be fairly compared with the figures of the Meteorological Department. Accordingly a standard type of observatory shed was built and a set of instruments obtained from the Meteorological Department and figures for temperature, relative humidity and rainfall are now recorded. The figures obtained are now comparable with the records of the Meteorological Department for the stations at Lahore and Montgomery. The results of the first year's observations are given in the following tables.

For those unacquainted with the locality it may be mentioned that Montgomery is 80 miles south of Lahore and Changa-Manga is just half-way between these two places. The country is quite flat, there being no irregularities of greater height than canal and railway embankments between Lahore and Montgomery or, for that matter, for many miles north of Lahore and south of Montgomery. The ground slopes imperceptibly from north to south. The normal annual rainfall increases from 10·46 inches at Montgomery to 19·69 inches at Lahore. With this rainfall the country is little better than desert, except where irrigated. Round Lahore there is a good deal of irrigation, but the canal ends at Changa-Manga and the country between Changa-Manga and Montgomery is not irrigated at present.

At Changa-Manga there is an irrigated plantation of Shisham and Mulberry of about 8,000 acres actually irrigated. Irrigation is carried out during the hot weather, each portion being irrigated once and more often if water is available, but it seldom happens that as much as half the plantation gets a second watering in the year. The plantation is worked under the coppice-with-standards system, the rotation being nominally fifteen years, but actually nearer twenty years.

Approximately in the middle of the plantation is an unplanted area in which the rest-house and other buildings are situated, and here the observatory shed has been built. The shed is well removed from any trees so that it is not affected directly by the

shade of the plantation or of isolated trees around the buildings. If any conclusions can be based on one year's observations the figures show that the plantation has a very slight effect on the maximum, 10 and 16 hours' temperature. There is, however, a marked reduction in the minimum temperature, the reduction being greatest during the winter months and much smaller during the rainy season. This reduction of the minimum temperature has the effect of increasing the relative humidity calculated from the minimum. The relative humidity at 10 and 16 hours at Changa-Manga shows no great difference from the Lahore figures. At Montgomery 10 and 16 hours' humidity observations are not recorded, so that no comparison is possible. If the reduction of the minimum temperature is due to the plantation and not to any other cause, it is evident that the effect of the forest on the climate in this instance is the reverse to what Forest Officers have been brought up to believe.

The situation of the observatory may perhaps fairly be compared to a "frost hole" in a natural forest. No other situation is, however, available; since the shed must be sufficiently removed from trees to prevent their shade falling on it, roads and compartment lines are unsuitable, and if the observatory were situated outside the plantation, the plantation could have no effect upon the instruments when the wind was blowing from the shed towards the trees.

In conclusion, it may be remarked that figures for two observing stations in Lahore have been given in order to show that slight differences even in mean monthly figures are of no importance.

Mean Maximum Temperature.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	1912-13.
Lahore Station A. ...	99·9	95·5	100·2	96·3	80·7	71·9	73·1	70·4	78·0	97·9	2·	101·0	
Lahore Station B. ...	100·6	95·4	99·9	96·6	81·5	71·8	73·2	70·5	77·2	97·6	102·3	101·2	
Changa-Manga ...	100·3	99·7	98·7	95·7	79·7	72·1	73·0	70·3	79·0	97·9	102·9	100·7	
Montgomery ...	102·0	101·2	100·5	97 3	81·8	72·9	73·2	71·1	78·9	98·9	105·7	104·1	

Mean Minimum Temperature.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	1912-13.
Lahore Station A. ...	82·9	79·6	71·0	60·5	49·2	42·7	42·4	48·7	5 2·0	66·5	74·1	79·3	
Lahore Station B. ...	82·7	79·5	71·0	60·5	48·9	42·0	41·6	47·9	52·0	66·4	74·2	79·3	
anga-Manga ...	80·0	77·8	64·7	54·6	43·1	36·5	34·8	42·8	43·3	58·1	66·8	75·7	
Montgomery ...	83·9	81·7	72·3	63·2	50·6	43·3	42·5	46·7	53·2	68·5	78·1	81·6	

Mean 10 *hours' Temperature.*

1912-13.	July.	August.	September.	October	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A. ...	91·6	87·9	89·5	84·3	68·8	58·1	58·3	59·6	68·3	87·2	92·4	91·6
Changa-Manga ...	95·3	88·9	87·1	81·7	66·8	57·8	57·7	59·2	68·1	86·1	91·2	91·0

Mean 16 *hours' Temperature.*

1912-13.	July.	August.	September.	October.	November.	December.	January.	February	March.	April.	May.	June.
Lahore Station A. ...	97·5	93·2	98·2	94·1	77·9	69·2	70·3	68·0	76·3	96·2	100·2	99·4
Changa-Manga ...	97·0	93·5	96·2	93·5	78·7	70·5	72·0	68·4	77·0	4	100·3	99·9

Highest Maximum Temperature.

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A. ...	109·8	102·1	103·3	103·4	89·6	77·6	78·4	76·3	94·6	103·8	112·2	111·2
Lahore Station B. ...	111·9	101·9	103·4	103·4	90·9	77·4	78·4	76·4	91·4	103·9	112·4	111·4
Changa-Manga ...	110·8	102·5	101·8	102·2	89·0	77·2	78·8	77·4	96·4	103·6	112·4	110·2
Montgomery ...	111·9	106·4	103·4	103·9	90·9	78·9	79·4	82·9	92·4	105·4	115·2	114·6

Lowest Minimum Temperature.

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April	May.	June.
Lahore Station A. ...	76·4	73·7	62·5	55·1	38·6	37·2	36·1	39·7	45·2	57·2	66·1	70·4
Lahore Station B. ...	76·2	73·7	62·7	55·2	38·7	37·2	36·2	39·7	45·2	57·2	66·2	70·2
Changa-Manga ...	70·7	73·3	54·9	49·2	35·0	30·5	29·0	32·2	37·0	49·2	52·0	69·3
Montgomery ...	72·5	77·0	64·0	57·0	39·0	37·0	37·0	40·0	42·5	59·0	64·5	71·2

Mean Relative Humidity from the Minimum.

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A. ...	76	86	75	7	83	83	80	85	78	61	61	74
Changa-Manga ...	87	91	91	92	95	97	94	91	92	81	82	84

Mean Relative Humidity at 10 *hours.*

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A. ...	61	70	43	37	49	58	53	69	48	30	36	51
Changa-Manga ...	67	70	51	45	53	55	52	67	50	33	41	55

Mean Relative Humidity at 16 hours.

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A. ...	51	61	30	26	38	42	33	51	33	19	27	39
Changa-Manga ...	56	63	41	33	36	31	27	51	33	25	30	42

Rainfall.

1912-13.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June	Total.	
Lahore	1·65	8·00	...	...	0·19	0·17	0·03	1·39	1·50	0·04	3·29	1·67	17·83	Inches.
Changa-Manga ...	4·66	3·50	1·18	...	0·24	...	...	2·41	0·69	0·11	0·95	2·44	16·18	Inches.
Montgomery	2·74	2·06	0·20	...	...	0·02	...	1·32	0·45	0·09	0·01	1·09	7·98	Inches.

NOTE ON ANWAL *(CASSIA AURICULATA)* BARKS FROM MARWAR.

BY PURAN SINGH, F.C.S.,
Chemical Adviser to Forest Research Institute, Dehra Dun.

The Superintendent of Forests, Marwar, writing to the *Forest Economist* on the above subject, gives an interesting description of the occurrence of *Cassia auriculata* in Marwar locally known as "Tarwar." He writes that the species grows locally as a perennial gregarious under-shrub over a belt of 10 to 30 miles at the western foot of the Aravallis Hill range of Rajputana, in the south and south-west corner of Marwar State. The shrub is generally found growing along the river courses, low lands and in and around cultivated areas, where it adds much to the beauty of the landscape by its profusion of golden yellow flowers, almost all the year round. It does not grow well in reserved forests or in any well-wooded area.

As regards the local use of the tannin bark, it is said that it is preferred to *Babul* and *Bhunbaoli* root (*Acacia Jacquemonti*) barks, though the two latter are common in the said tract and are abundantly available on account of the ease with which they can be stripped from the wood. The annual revenue of the Marwar Forests has, during the last year, *viz.*, 1913, risen from Rs. 2,000 to Rs. 14,000, the annual export of the bark to the Sindh and Bombay markets is roughly estimated to be from 4,000 to 25,000 maunds, while the estimate of the local consumption in Marwar is put at 25,000 maunds. The total output of Marwar State thus comes up to 50,000 maunds. The bark is sold at an average price of Rs. 2-8-0 per maund, delivered at the nearest railway station.

The exploitable age of the tree for the bark.

Three samples of the bark were received from the Superintendent of Forests with a view to determining their tannin percentage and fixing the correct exploitable age.

It may be stated here that the samples of this bark examined for tan in content at the Imperial Institute, London, and referred

to by Sir George Watt in his "The Commercial Products of India," page 291, showed a great variation in percentage, but as shown by Dr. Hooper in Agricultural Ledger, 1902, No. 1, page 27, this variation was mostly due to the samples being drawn from the trees without any reference to the age of the latter. The percentage of tannin in this bark as recorded at various places ranges from 11 to 22 per cent.

The following table gives the results of the said three samples from Marwar as examined at this Institute by the chromed hide powder process of I. A. L. T. C. :—

Serial number.	The sample mark and the description.	Moisture %.	Total solids of aqueous extract %.	Soluble solids %.	Insolubles %.	Non-tannin %.	Tannin %.	Tannin calculated on the dry material %.
1	A. 3—5 years old bark from a reserved area.	12·92	35·28	33·63	1·65	11·26	21·03	24·15
2	B. One year old bark from shoots of stumps exploited for bark in an open jungle.	13·58	30·86	30·62	0·24	10·02	20·60	23·83
3	C. 3—6 months old bark from coppice shoots.	10·40	31·33	29·94	1·39	11·75	18·19	20·28

From the above table, it is evident that the bark from the old trees is richer in tannin than that obtained from young shoots of less than one year. There is no practical difference in the tannin content of the bark grown one year old or 3—5 years old. Hence it may be said at once that the bark grown for one full year should be considered mature enough for exploitation so far as its tannin percentage is concerned.

These results confirm the statement of Dr. Hooper that the mature bark gives more tannin than the young bark, though no figures determining the economic age of cutting or the age of the bark experimented on by him are given. The results as reported

in Agricultural Ledger, 1902, No. 1, page 27, may well be given here for comparison :—

	Young bark.	Mature bark.
Percentage of tannin	11·92	20·12
Phlobaphene (insolubles)	2·30	4·90
Extract (aqueous)	22·35	29·00
Ash	4·15	6·40
Moisture	7·26	7·80

The samples analysed by Dr. Hooper were obtained from Madras, and the young bark from there gives only 12 per cent. of tannin. It appears that not only the age, but also the locality has its effect on the tannin content. A sample of bark obtained from one inch young boughs gave 11 per cent. as reported in the Technical Report of the Imperial Institute, London, for 1903, page 186. Another sample anaylsed by Dr. Leather at Dehra gave 15 per cent. tannin. A sample of this bark received from North Canara and analysed by the writer in 1910 gave : moisture 12·46 per cent., total solids 31·34 per cent., non-tannins 10·92 and tannin 20·42 per cent.

The mature barks from Marwar are the richest in tannin of all the samples so far examined, while that obtained from 5—6 months old shoots containing 18 per cent. of tannin is also a higher average than that of any other sample of immature bark examined up to date.

The utilization of the tarwar bark.

The ***tarwar bark***, though universally used in India, has up to the present not obtained sufficient recognition in England, taking into consideration its excellent properties. Professor Procter (see Reports Soc., Arts., 1904) places this bark as one of the "Catechols," and speaks of the "thoroughly unsatisfactory character of the ***tarwar*** tannage for the use of book-binding and upholstery," and asks whether there may not be other more

desirable materials. This indicates that the value of the tannin extract of *tarwar* will have yet to be recognised in spite of the fact that the *tarwar* bark yields a superior tannage to that of the mangrove, which too is a "Catechol."

The great abundance of the *tarwar* bark as reported in Marwar allows it to be considered as one of the materials for the possible manufacture of tannin extracts, though without knowing the market value of this extract, it is not possible to say whether it can be manufactured at a profit. But taking it as a "Catechol" bark, the price of the extract cannot be very different to that obtainable for the mangrove extract, though a rather higher value may be expected on account of the lighter red colour in the bark and the superior tannage given by it. In any case, the price at which the bark is selling at present in Marwar prohibits its use as a raw material for tannin extracts. The first thing to be done is to reduce the cost of its production to about Rs. 40 per ton.

It is further suggested that the bark should be powdered and exported in the powdered form. Nevertheless before attempting to find an export market, it may be found more profitable, looking to the scarcity of the *Babul* bark in India, to extend its sale in this country.

A FURTHER NOTE ON THE BEST SEASON FOR COLLECTING MYRABOLANS AS TANNING MATERIAL.

BY PURAN SINGH, F.C.S.,

Chemical Adviser to Forest Research Institute, Dehra Dun.

A short note on the subject appeared in the *Indian Forester*, Vol. XXXVII, No. 9, page 509. The conclusion given therein that the myrabolans should be collected when they are perfectly ripe is further supported by the following table showing the results of tannin estimation of thirty-five samples of myrabolans from Madras and Balaghat. The samples collected in March in all cases were richer than those collected in October. Taking a variation of 2 per cent. as negligible, it will be seen that out of ten

lots (two being not strictly comparable) six show that the samples collected in January and March have the same percentage of tannin while only four lots show that the January samples are richer than those in March. It seems that all depends on the time when the myrabolans ripen in different localities. The Madras samples are generally ripe enough for collection in January.

In conclusion, it may be said that instead of allowing the myrabolans to remain as long as possible on the tree as suggested in the previous note on the subject, it is recommended that they should be collected as soon as they are fully ripe.

The tannin estimations given in the following table have been made by the chromed hide powder process :—

Table of Analysis of 35 samples of Myrabolans from different localities.

Serial number.	Locality.		Date of collection.	Moisture %.	Total solids %.	Soluble solids %.	Insolubles %.	Non-tannin %.	Tannin %.	Tannin % on the dry materials.	REMARKS.
1	West Kurnool, Northern Circle, Madras.	I	1st—20th October 1912.	13·94	...	62·00	...	19·18	42·82	49·76	
2			5th January 1913	14·65	75·20	71·68	3·52	10·64	50·73	59·45	Nearly the same.
3			March 1913 ...	20·56	65·12	62·00	3·12	16·53	46·47	58·50	
4	Upper Godavari, Northern Circle, Madras.	II	12th October 1912	14·31	56·20	53·48	2·72	15·64	37·84	44·15	
5			7th January 1913	16·35	70·48	68·76	1·72	14·32	54·44	65·08	
6			17th March 1913	14·40	...	70·80	...	26·10	44·70	52·22	
7	Vizagapatam—(i) Golugonda Range, Northern Circle, Madras.	III	10th October 1912	16·63	59·20	57·60	1·60	17·49	40·11	48·11	
8			10th January 1913	16·43	...	66·20	...	19·10	47·10	56·34	
9			10th March 1913	14·60	71·56	69·52	2·04	15·01	54·51	63·83	
10	Kurnool East—(i) Morricherum Range, Northern Circle, Madras.	IV	20th—24th October 1912.	14·77	65·68	63·20	2·48	17·36	45·84	53·78	
11			17th—20th January 1913.	14·20	71·20	67·48	0·72	15·84	51·64	60·19	
12			End of March 1913.	13·54	70·56	69·08	1·48	21·32	47·76	55·24	

Table of Analysis of 35 samples of Myrabolans from different localities—(concld.).

Serial number.	Locality.		Date of collection.	Moisture %.	Total solids %.	Soluble solids %.	Insolubles %.	Non-tannin %.	Tannin %.	Tannin % on the dry materials.	Remarks.
13	(ii) Dornal Range, Northern Circle, Madras.	V	30th October 1912	14·36	62·92	60·40	2·52	19·11	41·29	48·21	
13a			January 1913 ...	Not received.							
14			18th April 1913 ...	17·16	67·76	64·16	3·60	18·05	46·11	55·69	
15	(iii) Markapur Range, Northern Circle, Madras.	VI	15th October 1912	14·85	63·60	60·68	2·92	20·05	40·63	47·71	
16			January 1913 ...	15·95	...	72·64	...	20·62	52·02	61·93	
17			March 1913 ...	14·15	...	64·88	...	19·80	45·10	52·52	
18	Western Circle, Madras, South Coimbatore—(i) Anamalai Hills.	VII	2nd October 1912	9·32	72·00	70·60	1·40	12·07	58·53	64·55	March sample the richest.
19			2nd January 1913	15·18	...	68·80	...	14·14	54·66	64·45	
20			March 1913 ...	14·53	71·64	70·32	1·32	13·05	57·27	67·00	
21	Western Circle, Madras, South Coimbatore, Kollegal Range.	VIII	16th October 1912	14·40	...	70·08	...	15·22	54·86	64·07	
22			27th January 1913	13·55	72·12	71·08	1·04	12·15	58·93	68·17	Nearly the same.
23			17th March 1913	13·77	72·92	70·12	2·80	12·62	57·50	66·63	

24			October 1912 ...	13·89	...	61·80	...	16·06	45·74	53·12	
25	Western Circle, Madras, North Coimbatore, Satyamangalam Range—(i) Gaddesale.	IX	January 1913 ...	12·74	67·78	65·08	2·70	18·66	46·42	55·18	Equally rich.
26			March 1913 ...	15·47	...	60·84	...	13·99	46·85	55·56	
27	Western Circle, Madras, Satyamangalam Range—(ii) Germalan.	X	October 1912 ...	13·30	...	61·04	...	13·05	47·99	58·80	
28			20th January 1913	14·87	...	70·28	...	14·57	55·71	65·46	Nearly the same.
29			20th March 1913	13·51	...	61·20	...	18·49	54·51	63·02	
30	Nilgiris, Madras—(i) Segur Range.	XI	October 1912 ...	15·65	...	67·00	...	16·99	50·03	58·12	
31			6th January 1913	14·32	...	69·70	...	13·49	56·21	65·60	Nearly the same.
32			March 1913 ...	14·14	...	71·88	...	16·53	55·35	64·47	
33	Balaghat, Central Provinces, Baihar Range.	XII	20th October 1912	16·46	...	62·92	...	16·53	46·39	55·53	
34			18th January 1913	13·42	...	71·64	...	18·71	52·93	61·13	
35			March 1913 (collected from a different tree).	18·99	93·80	62·96	0·84	19·14	43·82	54·07	Not comparable with Nos. 33 and 34.

PUNJAB FOREST SCHOOL, FINNAL EXAMINATION, 1914.

The Final Examination of the Punjab Forest School was held in the second week of October 1914 at Chariban in the Rawalpindi Division. The Board of Examiners consisted of Messrs. M. R. K. Jerram, D.C.F., and E. A. Greswell, A.C.F., assisted by the Instructor in charge of the school.

In the beginning of the course in March last, ten students had joined the class, one of whom left the school, and another had to go on long leave. Of the remaining eight students who attended the final examination, all have been successful. Five of them have passed with 'credit' obtaining over 75 per cent. of the total number of marks.

On the morning of the 14th October 1914, the President announced the results, and, after a short but instructive speech to the out-going students regarding their future work in the department, handed over the following prizes :—

(1) First prize in Practical Forestry, for the best student of the year, offered by the Instructor, was won by Manohar Das, Forester, from Bashahr Division.

(2) Second prize in Practical Forestry, offered by the Instructor, was given to Shib Dayal, Forester, Bagat State, Simla Division.

(3) Third prize, offered by B. Bahadur Singh, Range Officer, Upper Murree, was awarded to Abdul Rashid, Deputy Ranger, Resin Division.

The meeting then dispersed with a vote of thanks to the Examiners.

PREM NATH,
Instructor, In charge of the Punjab Forest School.

EXTRACTS.

WHAT IS FORESTRY?

(BEING A CIRCULAR ISSUED BY THE CANADIAN FORESTRY ASSOCIATION IN THE "*Canadian Forestry Journal*" OF JUNE-JULY 1914.)

What is Forestry?—Forestry is the science and art of making the best permanent use of the forest.

For what purpose?—To increase the wealth and comfort of man. It seeks to preserve forests only in so far as these may minister to man's well-being.

Does it demand that no trees be cut?—No. It aims to have every acre of land in the country put to its highest use: Wheat-land to wheat, pasture-land to pasture; pine-land to pine; spruce-land

to spruce, and so on. It would clear farming lands as soon as that may be done profitably, but it urges that absolute forest land be so cut over that a new and better crop of trees will take the place of the virgin crop.

What is absolute Forest land?—Land that will never grow anything profitably but trees.

What interest has Canada in Forestry?—Over half the soil of habitable Canada is fit only to grow trees.

Is not lumber going out of use?—On the contrary, in spite of concrete, steel and other substitutes, more lumber is being used to-day the world over than ever before. The price of timber is constantly rising. Nearly all the countries of the world are importing timber. Canada is one of the very few timber-exporting countries. In her large forest area Canada has a resource which should go on increasing in value every year.

Would Forest preservation kill lumbering?—No. Forestry does not prohibit the cutting of ripe trees any more than agriculture forbids the cutting of ripe wheat. It simply asks that cutting on non-agricultural lands be done in such a way that a new and better crop will come on. It also asks that timber areas be protected from fire and from injurious insects, so as to save both the mature trees and the young forest, the hope of the future. It looks to making lumbering (timber harvesting) just as permanent a business as farming.

Would not Forests crowd out Farms?—No. All the land that the Forester asks for permanent forests is land unfit for farming—too poor, too hilly, too stony. The attempt to farm this land results in poverty, abandoned farms, man-made deserts. On the other hand, the maintenance of forests on such lands means a distinct gain to agriculture, especially in regard to moisture conditions, wood-supply, wind-breaks, covers for insectivorous birds and evenness of stream flow. Every interest in the country, in fact, is benefited and none injured by retaining forests on non-agricultural lands.

Is Forestry worth while?—It is. The value of forest products in Canada in their first stage of manufacture (in the saw-mill yard)

is estimated by the Dominion Forestry Branch at $170,000,000 per year. This timber is at the base of all our manufacturing. It forms a great proportion of our transportation business, and the maintenance of forests on the uplands keeps our streams in even flow, thus preserving our water-supplies and water-powers. Forests are also great health resorts and game preserves.

Have we not plenty of Timber?—We used to think so, but now we know that a few decades will see the remainder of our virgin timber cut. Some authorities think the United States will have exhausted their virgin timber by 1930 or 1935. Then, if they should come to Canada to get their supply, our authorities tell us our timber would last seven years.

What can be done?—The first thing to do is to stop forest fires which consume at a dead loss seven or eight times as much timber as the axe of the lumberman. The great factor in this is the educating of public opinion. When the public is aroused forest fires will stop. Much can be done by disposing of the *débris* left after lumbering, by screening smokestacks of locomotives, regulating times of settlers' brush-burning, and by patrolling timber lands to reduce the danger from tourists, campers, prospectors and from lightning. When forests are protected, then will come methods of reforestation.

Does anybody care?—Many care, but not all. Last year the different Governments in Canada spent considerably over one million dollars in forest protection and administration, chiefly in fire-protection. Lumbering and railway companies and private individuals spent half a million more. This included trail and telephone-line building and the introduction of oil-burning locomotives on some railways.

How can I help?—One of the most efficient methods is by joining the Canadian Forestry Association. This is the national organization which has for its object the awakening of the public to the need and value of forest protection. In numbers there is strength, and those who believe in forest conservation have, by banding together, done much more in getting governments, corporations and private individuals to adopt better methods

than they ever could have done by separate effort. The work of the Association, which is constantly growing, has been endorsed by leading public men. Joining the Association will keep you informed of what is being done and show you how you can help. The membership fee is the nominal one of one dollar per year, and this entitles members to receive without further charge, the *Canadian Forestry Journal* (monthly), the report of the addresses, papers and discussions at the Annual Convention, and other publications issued from time to time. If you are already a member you can assist by sending in the names of those who may be interested.

SUGAR FROM SAWDUST.

In a recent paper read before the Society of Arts by Mr. A. Zimmerman, a method of treating sawdust is described whereby this insoluble and comparatively useless substance can be partially converted into a soluble and useful substance—useful both from the point of the distiller and of the agriculturist. The exact chemical constitution of this sawdust-derived compound has not yet been determined, but it has been clearly proved to be a substance allied to glucose and sugar. It is probably neither common glucose nor common sugar, but it is a saccharine substance, fermentable, like glucose and sugar, and can be converted into alcohol. This conversion does not of itself interest agriculturists, but certain experiments have been performed, calculated to determine the value of this new substance—sacchulose it is called—as a feeding stuff, and these are of considerable importance to all interested in the feeding of stock. The method of manufacture of sacchulose by what is called the classen process is briefly as follows:—Sawdust is subjected, in close retorts, to digestion with a weak solution of sulphur dioxide, under a pressure of about 100 pounds to the square inch. About 25 per cent. of the wood is thus converted into a soluble saccharine compound. Other products are formed, but these do not seem to be of the same importance from the

agricultural point of view. The following table shows the composition of sawdust after treatment as above :—

COMPOSITION OF SAWDUST BEFORE AND AFTER CONVERSION.

Substance.	Before conversion.	After conversion, the volatile substances being drivenoff.
	P. C.	P. C.
Ash	0·7	0·7
Saccharine matter	...	25·0
Other carbohydrates soluble in acid and alkali	31·0	18·0
Carbohydrates insoluble in acid and alkali ...	68·3	56·3
	100·0	100·0

Sacchulose, when prepared, is exceedingly porous, and the saccharine matter is evenly distributed throughout the mass. The new substance sinks much more quickly in water than wood does, owing to the water more readily finding its way through the porous mass. In order to prevent the reduction of the surface attack by the gastric juice, molasses is allowed to run in and fill up the interstices. Fats may also be used. It has been shown that live-stock and working animals gain weight when molasses-sacchulose is included in the food ration. A critic has pointed out that possibly the improved condition was as much due to the inclusion of molasses in the ration as to the fact that sacchulose was part of the diet. Certain experiments, however, were made on sheep, the animals being fed with a maintenance ration plus sawdust, and afterwards with the same maintenance ration plus sacchulose. In this case it was found that there was a real increase in weight of over two pounds, which was put down as due to the sacchulated ration. Sacchulose cannot compete with white glucose for sugar boiling. It can, however, be converted into caramel, and it could be used in the brewing industry where priming is necessary. By bacterial action butryic acid could be prepared, and therefore sacchulose is not without interest to manufacturers of margarine. The most important use to which sacchulose can be put is undoubtedly the production of alcohol. A factory capable of heating 200 tons of sawdust per week could turn out between 300,000 and

400,000 gallons of proof spirit per annum. This would also give by-products, estimated as 50 tons of acetic acid, of furfurol, and 2,000 gallons of methyl alcohol. The mode of formation of the saccharine matter from wood by the classen process is quite unknown. Some authorities believe that the syrupy products are formed directly from the ligno-cellulose of the wood, a substance similar to starch in composition. Others hold that it is more likely that they are formed from the other bodies present in the wood. No saccharine compounds have yet been prepared from cotton or other pure cellulose bodies, when experiments were made on these under similar conditions to those holding for the manufacture of sacchulose from wood.

If sacchulose is to be prepared on a large scale in this country, most of the wood would have to come from abroad. Its manufacture may stimulate the still deeper interest in forestry, and do much to extend wooden areas throughout the kingdom. It is to be hoped that experiments will be repeated on a large scale in order to demonstrate fully to agriculturists the full value of sacchulose as a feeding stuff and how it ought to be used among live-stock.—[*North British Agriculturist.*]

EDIBLE FUNGI.*

BY W. A. MURRILL.

The use of mushrooms in this country is as yet very limited, and every season an immense quantity of nutritious, digestible and palatable food goes to waste in our fields and forests which would be utilised in China and many other parts of the Old World. The reason for this is ignorance and fear; lack of knowledge regarding the edible kinds, and a very definite impression that some of them, or most of them, are dangerous.

All knowledge regarding the edible and poisonous properties of mushrooms is based on experiments, either intentional or unintentional. The only safe rule is to confine oneself to known

* Abstract of a lecture delivered at the New York Botanical Garden and published in the *Journal* of that institution.

edible forms until others are proven harmless. If one is a beginner, he is like an explorer in a new country with an abundance of attractive fruit near at hand, which may be good or may be rank poison ; he cannot tell without trying it, unless some native, who has learned from his own and other's experience, shares his knowledge with him.

The majority of fleshy fungi are edible. A certain number are bitter, or peppery, or slightly poisonous, or otherwise objectionable, but not deadly. Their digestibility often depends on the way they are prepared and cooked, and on the peculiarities of the individual who eats them. A few are deadly poisonous. Two species, *Venenarius phalloides* and *V. muscarius*, are responsible for most of the deaths from mushroom-eating the world over. If these two were thoroughly known and avoided in the vicinity of New York city, there would probably be no fatalities here from mushroom-eating for the next ten years.

My advice to beginners is to confine themselves at first to groups that contain no poisonous species so far as known, or to certain species that cannot be easily confused with harmful ones.

EDIBLE FUNGI FOR BEGINNERS.

Common mushroom, morel, chantarelle, beefsteak, and sulphur-colored polypore.

Shaggy-mane, common inkcap, and glistening inkcap.

All puffballs, provided they are white, tender, and homogeneous within.

All coral-fungi, if they are fresh, crisp, tender, and have no bad odor nor bad taste.

The oyster mushroom and its near relatives. These are large, with white gills and short stems, and grow on dead wood above ground.

After considerable study and experience, more difficult distinctions may be made and other groups taken up.

SOME CRITICAL EDIBLE SPECIES.

Polypores that are sufficiently tender, avoiding certain Boleti and *Fomes Laricis*.

Boleti that have been tested and found edible, avoiding *Suillellus luridus*, *Ceriomyces miniato-olivaceus*, and *Tylopilus felleus* in particular, or all species with red tube-mouths and bitter or peppery taste, and species that turn blue quickly when handled.

Species of *Russula* and *Lactaria* with pleasant odor and flavor, avoiding such species as *L. rufa*, *L. torminosa*, *R. foetens*, and *R. emetica*.

Several species of *Lepiota*, avoiding *L. Morgani*, with green spores, and species of *Venenarius*.

Marasmius oreades must not be confused with *M. urens*, nor with *Inocybe infida*.

Clitocybe, *Tricholoma*, and *Collybia* are usually edible ; avoid *Clitocybe illudens*. *Vaginata* too closely resembles *Venenarius*.

Before attempting to use mushrooms at all for food, one should become acquainted with the chief poisonous species, if possible, by consulting any one of several books on mushrooms to be found in the public libraries. The deadly poisonous species are included in the genus *Venenarius*, formerly known as *Amanita*. *Venenarius cothurnatus* is much more common farther south, and *V. solitarius* can hardly be called deadly.

THE CHIEF POISONOUS SPECIES.

Venenarius phalloides, *V. muscarius*, *V. cothurnatus*, and *V. solitarius*.

Clitocybe illudens.

Inocybe infida.

Panus stypticus.

Chlorophyllum Molybdites (Lepiota Morgani).

Russula and *Lactaria*, about ten species.

Rosy-spored species, a few.

Several of the phalloids, probably.

Several species not yet tested, doubtless.

Note that no brown-spored, purplish brown-spored, nor black-spored species are listed above, but not all have been tested.

Nearly two hundred water-color drawings of local edible and poisonous mushrooms have recently been installed in the public museum of the New York Botanical Garden. These are not accompanied by descriptions, nor are the edible species designated, but the student of fungi will have no difficulty in recognising most of the common local species from these drawings alone.

PREPARING AND COOKING MUSHROOMS.

Reject old specimens of those infected with insects, cut off the stems except in rare cases where they are unusually tender, peel a few kinds that seem to require it, wash quickly in cold water, drain and keep in a cool place until ready to cook. As a rule, mushrooms cannot be kept very long in a fresh condition, and this is particularly true of certain very desirable species. When more are collected than can be used at once, it is best to boil them ten minutes, drain, keep in a cool place, and finish the cooking next day as desired. If allowed to stand in water, the flavor is impaired; also, peeling may remove some of the best flavored parts.

Detailed directions for cooking mushrooms are given in most of the books. The most practical and successful methods resolve themselves into broiling, baking, and stewing. In the first, which I prefer to all other methods, the mushrooms are cooked thoroughly but as quickly as possible on both sides over a hot fire; seasoned with pepper, salt, butter, and perhaps small bits of toasted bacon; and served hot on toast. *To bake mushrooms,* line the pan with toast, add the specimens, season, pour in half a cup of cream, cover closely, and bake rather slowly for fifteen minutes or more, according to quality. In stewing, the mushrooms are boiled in water until thoroughly cooked, then seasoned, thickened, and served on toast. This last method is often used for the tougher or poorer varieties.—[*Scientific American.*]

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TWO WIRE-ROPEWAYS.

Of all ventures into the territory of the Engineer one is—or, should I say, was—looked on by the Forest Officer as the most hazardous : and yet probably no means of mechanical transport is so well adapted for the solution of many of our difficulties in the extraction of produce as is the modern wire-ropeway. Small timber, sleepers, fuel, bamboos, grass and a multitude of minor products, in fact anything that can be made up into small loads, are suitable for aerial freight. As the weight of the loads increases the peculiar advantages of a ropeway diminish.

Speaking broadly, the main points in favour of this type of locomotion are :—

(*i*) Hilly, even mountainous country, or country cut up by ravines or gorges, that would be extremely difficult to open out by epigeal systems can be readily served by ropeways.

(*ii*) A ropeway is generally erected on an absolutely straight alignment and is therefore, in hilly country, much shorter than any road or tram-line constructed for

the same purpose would be. In one case in South India 27 miles of road and tramway were constructed where 17 miles of ropeway would have served.

(*iii*) Neither floods nor snow affect the working of the line.

(*iv*) The plant or the head of the plant can be transferred to a new alignment comparatively easily.

(*v*) When the gradient is favourable the plant can be worked by gravity, irrespective of intervening ridges over which the loads can 'syphon' to the lower ground beyond.

2. There are many systems. These may be primarily divided into—

(*i*) Travelling cables, and

(*ii*) Fixed cables with or without a hauling line.

The recently erected plant at Patriata in the Punjab follows the first system. A strong cable travels round and round between the two terminals over intermediate supports, carrying loaded trucks, which are clipped into it, in one direction and 'empties' in the reverse direction. It cost Rs. 21,000 per mile; it is three miles long and includes a telephone service and a driving engine.

The chief items in this sum are stated below :—

	Actual.	(*Vide* below.)
	Rs.	Rs.
(*a*) Expert's expenses, per mile	4,000	3,000
(*b*) Transport (rail, Rs. 300; road, Rs. 600)	900	900
(*c*) Erection, survey, tools, etc.	700	600
(*d*) Remodelling foundations	1,500	...
(*e*) Replacing original carriers	400	...
(*f*) Cost of material	13,500	13,500
	21,000	18,000

The second column of figures indicates the probable cost of a similar plant erected in the light of the experience gained at Patriata. If wooden trestles were substituted in a new scheme instead of the iron ones of Patriata a saving of about Rs. 6,000 per mile in the cost of material would be effected, excluding the value of the wood used.

After allowing for depreciation and for interest at 3½ per cent. there appears to be a surplus of Rs. 3,200 per mile. The carrying capacity of the line is about 12,000 tons or 36,000 ton miles per year. (These figures are deduced from the Punjab Forest Administration Report of 1911-12.)

3. Fixed cables are by far the more common system both on the Continent and in America.

The simplest form consists of a single cable down which the carriers slide by gravity. In an old plant in the Jaunsar Division of this type the carriers were blocks of hardwood, a *groove cut in them ran on the cable. The load was fastened on* by cheap ropes and the carriers were taken up the hill again by coolies.

The more elaborate forms have two cables and a continuous hauling rope all mounted on brackets projecting from iron or wooden trestles. The cable is kept taut by means of heavy weights attached to one end and suspended over a pit. A single cable rarely exceeds three miles in length, but the carriers, little two or four wheeled trucks, pass from one on to the other over a short length of rail.

The hauling rope may be operated by the weight of the loads, if the loading terminal is at a higher elevation than the unloading depôt, but frequently, especially in long lines, engines are used to keep the hauling rope circulating over the free wheels on which it rests.

4. A somewhat novel form of a fixed cable plant has been designed and patented by Mr. C. H. Donald, Rampur, Simla district, which he calls 'The timber carrier.' The interesting and most descriptive pamphlet which he has issued only deals with single spans up to 3,000 feet in length, but there is no reason,

as he himself suggests, why two or more such lengths should not be joined together by transfer rails of suitable design.

The plant consists of one cable stretched between an anchor at one end and a horizontal capstan at the other. There are no intermediate supports beyond two frames at either end over which the rope passes in order to raise it clear of the ground. A thin continuous wire hauling rope runs in vertical sheaves or grooved wheels placed at either terminal. This is attached by simple means to the load whose momentum is sufficient to keep the rope moving round the sheaves and to bring uphill the 'empties' attached to it. The lower sheave has a tightening arrangement to keep the hauling rope taut and also a fitting to bear a band-brake, thus allowing the pace of the carriers to be regulated.

The carriers consist of a single grooved wheel, with either one or two rods fixed to its axle and ending in a hook below the cable. Into these hooks the load is fastened by ropes with rings at each end. 'Empties' consist of the grooved wheels and a few light ropes and are carried in a bucket which is fastened on to the reverse hauling rope.

The plant is simple, easy to work and cheap. The patentee's figures of the capital cost and the weight are as follows :—

For a single span of ropeway 3,000 feet in length—

	Rs.	Weight in lbs.
(*i*) Fixed cable 3,000 ft., circumference one inch ...	160	468
(*ii*) Hauling rope 6,000 ft., circumference half inch ...	246	240
(*iii*) Upper sheaves	30	50
(*iv*) Lower sheaves with band-brake	100	90
(*v*) 50 carriers, at Rs. 6 each	300	400
	836	1,248 lbs. or about ½ a ton.

Loads up to 300 lbs.

For heavier loads, two or more cables are used placed horizontally beside each other and each load has two or more carriers, one in each cable.

The cost of working is indeed remarkable when compared with that by means of coolie labour.

A single span of 3,000′ feet, with three cables can take 600—800 B. G. sleepers in a day (say 20,000 tons or 11,500 ton miles per annum).

The following figures are based on the lower figure:—

The Timber Carrier.	Rs.	a.	p.	Coolie labour.	Rs.	a.	p.
(*i*) Wages of 10 coolies, at 12 annas per cap per diem.	7	8	0	600 B. G. sleepers, at 3 annas each.	112	8	0
(*ii*) Lubricants	0	4	0				
(*iii*) Miscellaneous	0	4	0				
	8	0	0		112	8	0

The saving is Rs. 104-8-0 every day!

(Depreciation and interest, omitted above, would not exceed 8 annas per day.)

The chief points of the system are that there are no intermediate trestles, that the cables and indeed the whole plant is very light, additional strength being obtained by adding to the number of the cables and not to the diameter, thus keeping the plant eminently portable, that it is easy to erect and to keep in order and that the initial cost and working expenses are low.

It will no doubt not be long before its present maximum length of 3,000 feet can be increased by joining two or more spans together. Local conditions will of course somewhat affect the method of erection in each case, but I would suggest that the tightening capstan for the cables should be at the lower end rather than at the upper if the grade be steep, and that an emergency brake should be fixed to the other side of the brake sheave. The cost of carriage and of erection will also vary, but as 25 coolies

can carry the whole plant and ten can put it up in three or four days, neither item will be of great moment in calculating the capital cost.

One welcomes any sensible effort to cheapen the cost of or to facilitate transport from our forests—and Mr. Donald's scheme—it is but a small one at present—seems thoroughly practical.

5. The two examples of wire-ropeways cited above indicate how wide is the territory on which one sets one's foot when one essays the consideration of such schemes. The Patriata plant deals with the fuel supply of a large station situated at the other side of a valley and at a higher elevation than the loading depôt. An engine is required to drag the loads along the cable uphill and the control along the line is by telephone.

The 'Timber Carrier' is suitable for tapping a coupe, for negotiating a cliff or a ravine, it could be moved to a fresh area two or three times in the year and there erected by an intelligent guard, while its accessories probably do not include even a megaphone.

WILD CATTLE IN IPUR RESERVED FOREST, NELLORE DISTRICT.

On the banks of the river Kandleru, two miles above the point where it empties itself into the Bay of Bengal, are situated a group of Islands, known as the 'Ipur Reserved Forest,' named after the village in whose limits these are.

This Reserved Forest extending over 1,033 acres consists of two distinct zones of vegetation, one encircling the other. The central zone consists chiefly of *Mimusops hexandra, Maba buxifolia*, *Carissa spinarum* and *Acacia Latronum* with palms and screw pines in water-logged localities. A few Nim are also found scattered here and there while the outer zone consists of pure *Avicennia officinalis;* the tidal waves and the salt water do not seem to be conducive to the growth of other plants.

Nearly one hundred wild cattle have their home in this forest. It is not possible to state when exactly these animals came into

this forest or whence. Many stories are told about the migration of these into the Islands and the following one is most current.

It would appear that some years back, a rich Kapu lady who lost her husband, children and all near and dear to her, drove her cattle into these Islands, foretelling that the family of those who attempt to catch, molest or meddle in any way with them would be ruined as hers had been.

They may have migrated from Sriharikota Island, where the ryots leave them in the forests to roam at large and catch them only when they calve, by means of dogs specially trained for the purpose. These dogs tire the animals by driving them hither and thither and catch them by the nose. The owners then come, put a rope round their neck and take them home. After milching, the cows are let loose, the calves alone being kept at home. The cows return home in the evenings, till the calves get old, when both cows and calves are driven back into the forest to be caught only at the next calving season.

These Sriharikota cattle have their owners nominally at any rate, Ipur wild cattle however have none; it is considered a sacrilege to catch any of these and men are afraid to molest them.

These cattle are very different from the ordinary country cattle. Unlike the country cattle which are generally big, possessing massive bodies with short stout horns and well developed humps, these are smaller in size, with compact, hardy frames, and thin long, gracefully set horns. Their legs are clean and strong, standing well apart, their tails are thin and whip-like. The ears are erect and their sense of hearing acute.

They are impatient of strangers. At the appearance of a stranger, they gather and rush at him with their horns directed towards him; but when found alone they run away.

No one can fail to be impressed with the general appearance of these animals. It is very surprising to find that not one, among the whole lot of cows and bulls, is either sickly or weak. This peculiarity is either due to the production of healthy offspring by parents rendered strong and hardy by their free, and unrestricted

mode of life or because of the natural weeding out of the weaklings in their struggle for existence. Whatever may be the reasons, the fact remains that any one of the herd would be worth a prize at a cattle show.

The herds emerge from their haunts at dawn, roam at large all day, freely eating tender grass and leaves on the Island and return to their retreats at dusk. During the day the bulls graze separately from the cows and calves, the former, leaving the herd, go long distances off in search of fodder, while the latter remain in the Island itself, subsisting chiefly on the *Avicennia officinalis.* The domestic cattle also greedily browse these leaves; cattle feeding on these are said to yield more milk, though it tastes somewhat bitter.

There are four big bulls in the herd. In the evening the herd gathers together at a common rendezvous, dividing itself into four batches, each batch being accompanied by one of these bulls. These bulls take great care that no domestic bulls mix with their cows, though they mix freely with domestic cows, grazing on the Island. The offspring born to the domestic cows and the wild bulls are highly prized for transport purposes. They are of high mettle and quick walkers. It appears to be difficult to train them to the plough. For small single or double bullock bandies, they require to be gradually and gently trained. Harsh treatment makes them stubborn and unfit for any work.

No attempts have been made to domesticate these animals as the popular superstition ascribes to them a peculiar sanctity, the very Island in which these animals live is supposed to be the abode of a deity whose property they are. A bull was caught in recent years from the herd, by a bold Mahomedan, but the animal refused food and drink and he had to set it free, in order to prevent it from dying of starvation. A few days after the capture, it would appear that he lost his wife and some relations. This has naturally strengthened the superstition that attaches to these animals and no one would now dare to attempt to catch them.

The Forest Department are contemplating the domestication of these cattle with a view to turning them to some useful purpose.

if their attempts are successful, they would prevent their forests from being destroyed and cure the people of their superstitious feelings in connection with them.

V. N. SESHAGIRI RAO,
Ranger.

KASHMIR FORESTS.

It may interest some of our readers to hear of a step forward which has been made in forest matters in Kashmir.

Four years ago the Conservator suggested the building of a school and the starting of a class, the object being to teach and train a certain number of foresters and guards on the lines of the policy adopted in India.

For two years this scheme was under consideration and finally it was found possible to take the matter in hand, and the school buildings were begun, under the direction of the Divisional Forest Officer.

The situation chosen is an admirable one, on the slopes above Bandipore, overlooking the Wooller lake and close by the Gilgit road ; the site is open, well drained and healthy, and being above the town the views over the lake and valley are grand. There is a good spring of drinking water near, which eventually will be brought in pipes to a more convenient distance, and for the larger requirements, garden, etc., an irrigation channel has been built along the hillside for a distance of some six or seven miles tapping the river above. In addition to the training class buildings, consisting of students' quarters (already built), Instructor's house and Museum (not yet built) the head-quarters of the Division are to be transferred here which will include a bungalow for the Divisional Forest Officer, his office building and clerks' quarters.

The Divisional bungalow will shortly be begun, the site is being levelled and prepared, all the buildings are to be "pucca." Last year a class of eleven students was formed, from among the foresters and promising guards, already in State employ, their instructor being a Dehra Dun honors' man, and all was under the direct control of the Divisional Forest Officer. There were a number of applications for admission to the class, and the work of the first year has proved an unqualified success. There were a certain number of difficulties, unavoidable in the first year, these were successfully surmounted with credit by the Divisional Forest Officer and his staff and the examinations held by the Conservator from November 4th to 7th confirmed the entire success of the enterprise. The prizes were distributed on 7th and the new class will assemble for the next year's course in April next.

It has long been the Conservator's wish to start a school ; he was well aware of the necessity, but it is only in the past two years that it has come within the range of possibility, the object and aim being to train the men in the elementary work

and duties expected of them, to foster a better feeling and *esprit de corps* among the men and to attract a better class of men into the State Forest Service. It has been noticeable in the last few years that a better class of man has begun to come forward ; and a great inducement is now offered by the new promotion rules and regulations, framed by the Conservator and passed some little time ago by the Durbar, which so regulates promotions that any promising and competent man in the lower grades can now work his way up to the higher appointments, and it is hoped that by these inducements and the encouragement afforded by the new class, each succeeding year will see a marked improvement in the class of man applying for service in the State Forest Department.

This, we believe, is the first class of its kind started in any Native State. It certainly fills a long-felt want, and judging from the promising results of the first year it should prove a successful and fruitful enterprise in the future.

EXTRACTS.

WOOD DISTILLATION WORKS, FOREST OF DEAN. *

These works have been erected with the object of utilising the considerable quantities of almost unmarketable cord-wood and small branch-wood which are left over when the broad-leaved areas in Dean Forest and the adjoining woodlands are felled. The works were opened in October 1913.

The total capital cost has not yet been adjusted, but was approximately as follows:—

Buildings	£8,000
Machinery	6,500
Fittings, architect's commission, fencing, etc. ...	1,000
Total ...	£15,500

The patent process of Herr F. H. Meyer, of Hannover-Hainholz, was adopted, after enquiry, as the most suitable, and the machinery was designed and supplied by his firm, the engine, boiler and principal non-patented apparatus being of English manufacture. The buildings were erected from Herr Meyer's plans by Mr. E. Maples Linton, Architect, of Newport, Mon.

The works are designed to produce charcoal, wood tar, wood alcohol and grey acetate of lime, which is used in the manufacture of acetone. It is not intended at present to manufacture acetone, but the works have been designed for installing the additional machinery necessary for that purpose, if required.

The contractor estimated that the following products would be obtained from the plant by carbonising 420,000 cubic feet of wood per annum:—

Grey acetate of lime	384 tons.
Tar	270 „
Charcoal	1,380 „
Wood spirit	90 „

(equal to 23,400 gallons of 8·61 lbs. each).

* A pamphlet printed under the authority of His Majesty's Stationery Office by Messrs. Darling and Son, Bacon Street, London, E.

As production commenced only a few months ago, sufficient time has not yet elapsed for the purpose of enabling the results and estimates to be fully compared, but the experience already gained leads to the conclusion that the above output will scarcely be obtained.

Most of the wood used is oak, which is brought in by hauliers from the Crown forests, in the centre of which the works are situated, and is stored in large stacks, a stock of 1,500 to 2,000 cords being kept at the works.

The Process.—The retort for the carbonisation of the wood is built of iron plate and is about 56 feet in length and 7½ feet in diameter. It is fired from a furnace on the left side, and is set in flues which enable the wood to be carbonised effectually. The wood is packed into cylindrical-shaped trucks, each holding about two cords, or 256 cubic feet, stacked, and five trucks form one charge for the retort. When ready the iron door of the retort is lifted and the trucks of wood are drawn in by an electric motor. The door is then securely closed and the temperature raised to between 330° and 350° C. Distillation usually commences in about two hours and continues for twenty to twenty-two hours.

After the process is completed the door at the other end of the retort is raised, and the trucks, which now contain charcoal, are quickly drawn by motor into an iron cooling-chamber similar in form to the retort. The doors at each end of the cooling-chamber are made secure and the exterior is irrigated with water to expedite cooling. From the cooler the trucks of charcoal are removed, on the following day, to the charcoal shed, where they are emptied and the charcoal filled into bags ready for despatch.

During the process of distillation about 70 per cent. of the weight of the wood is given off in the form of gases, which pass out of the top of the retort through two copper pipes into a tar separator, where the tar is condensed and flows into a tank. The tar is then run into a *montejus* and lifted by a compressor into the tar still, where it is freed from the acid, oils and water remaining in it. It is run direct from the still into casks, and is then ready for marketing.

The gases and vapours, freed from tar, pass out at the top of the separator, and on into a tubular condenser, where the naphtha and acid vapours are condensed and run into large storage vats. This pyroligneous liquor, as it is called, is left in the vat three or four days to free it from any tar in suspension, and is then ready for further treatment.

The incondensible gases pass from the tubular condenser into a gas washer, where any residual naphtha or acid is removed by water, and are then conveyed by a pipe to the furnace, where they are utilised in the process of carbonisation.

The pyroligneous liquor, freed from tar, is pumped from the storage tanks across the yard to a vat in the acid room and neutralised with lime, which has been prepared in a lime-mixing tank outside. The liquor is stirred continuously by a mechanical stirrer until the mixing and neutralisation are complete. Thence it is pumped into settling tanks at the top of the building, then into sludge tanks on the first floor, where further impurities are removed, and thence into a storage tank in the acid room.

It is now pumped into a small "clear liquor" tank on the top floor, and runs thence into the iron column of the continuous apparatus, where the neutralised acid liquor is completely separated from the naphtha. This apparatus consists of a wrought-iron base or still, containing a copper coil, surmounted by a series of cast-iron plates. The neutralised liquor is run off continuously from the still into a tank below, and while still hot is pumped into an evaporating pan. It is there boiled down to a strength of about 10 degrees Baumé, and when this point is reached, is run into the pan of a rotary dryer. This is a large wrought-iron drum, heated internally with live steam. The drum revolves slowly in a shallow tank and picks up a coating of the neutralised liquor. The liquor is dried, as the drum revolves, to a content of about 70 per cent. of grey acetate of lime, and then removed by a series of scrapers on the other side. The acetate, which is now in a pasty condition, is spread upon a concrete drying floor, under which pass the gases from the retort to the chimney stack, and after being dried for several hours, is filled into sacks. The

acetate now contains from 84 to 85 per cent. of true acetate of lime.

The naphtha which runs from the top of the iron still and column, after being freed from the acetate of lime liquor as previously described and also from some of the heavy oils, is passed through a copper wash-column, into which a weak solution of sulphuric acid trickles, and is here further purified. Thence it goes into a second column, where it is treated with a weak solution of caustic soda, and more oils are separated out. After passing through a small condenser the purified methyl alcohol is run into a storage tank below, and is ready for filling into drums for despatch.

Power is provided by a 27 ft. by 7 ft. 6 ins. boiler, made by Messrs. E. Danks & Co., Ltd., of Oldbury, which supplies steam to the following machines :—a 35 H.-P. single-cylinder, non-condensing engine, made by Messrs Marshall, Sons & Co., Ltd., of Gainsborough ; a Worthington steam pump for cooling the water; the fan engine; the condenser engine; the evaporating pan ; the rotary dryer; the continuous apparatus ; the tar still; the tar condenser; and the boiler-feed pump.

The main engine drives by shafting a dynamo, which, in addition to lighting the works, provides power for the motors used in charging and discharging the retort and cooler, and for the acid pump, the neutralised liquor pump, the clear liquor pump, the evaporator pump, the lime stirrer and the rotary dryer.

BRITISH FORESTRY.

Not long ago the Public Press at Home was agitating the question of developing British forestry for the purpose of finding work for the unemployed; not that the condition of the unemployed was the best of reasons why the country should undertake a systematic extension of its forests, but it served as a strong plank of the platform on which a demand could be made for imperial funds to embark on the policy. At the time, however, strong opposition was raised to the idea that the unemployed could

be of much use in work of this kind, if indeed they did not prove a hindrance and a source of unwarrantable expense. Anyway, the claims of the unemployed were abandoned and the discussion ceased. To-day the effect of the war on the British timber supply has again opened the question, and we hope this time some practical measures will result; and they may if the advocates of the unemployed add their voice to the demands of those who are suffering from a scarcity caused by the war. Of course no one expects that England can ever be a self-supplying country, but she can do much more than is being done at present to reduce demands from outside even without encroaching upon her agricultural lands for conversion into forest. A change of policy and a systematic utilisation of waste lands is all that is wanted, in fact, to place her in a much better position than at present for meeting her demands for timber. As regards a policy, it must be noted that England has no Forest Department in the proper sense of the term. There is a Board of Agriculture and Fisheries and the Office of Woods which deals in one of its branches with forestry questions, but it has never had any funds to speak of for the practical development of forests. There are no State forests and beyond in a way encouraging the planting of oak and engaging in certain scientific enquiries, the branch of forestry has done nothing till very recently, when it made a review of the forestry possibilities of the country and prepared an outline scheme for afforestation and the improvement of forestry. It is ascertained that in England and Wales combined there exist 1,884,100 acres of woodlands, over 95 per cent. of which is privately owned. It is also ascertained that the whole area of afforestable land is about 2,500,000 acres, showing a fair margin between what is actually utilised as woodland and what is allowed to lie waste. The woodlands are worked under the direction of agents of their owners on no particular system, and are believed to be yielding only one-half the maximum possible. The report states that the annual imports into the United Kingdom of the principal kinds of unmanufactured timber amount to 24 times the amount of the annual production from British woods, the latter being put down under a liberal estimate

at 20 million cubic feet. If the area were to be increased to the figure given as afforestable and the yield doubled, the demand on imported timber would be reduced from 24 times to only 6 times the home supply, and probably a much better class of timber produced under proper forest management. The total value of timber and wood-pulp imported into the United Kingdom in 1912 was £36 millions, of which over 80 per cent. was derived from coniferous timber, a class of timber easily grown at Home. Taking the returns for fir and pit wood only, we find the value of imports given as nearly £22 millions; and as this represents 77 per cent. of the total value of unmanufactured timber imported, the total value of imported and manufactured timber must have been something under £28 millions. It will be something for State Forestry to be able to reduce this large figure by even £6 or £7 millions annually, which will be kept in the country and help to settle a portion of the floating population on the land. Since 1880 there has been a steady rise in the price of timber and accompanying it a deterioration in quality. At the same time the consumption per head of population has increased by 25 per cent. There is a clear case, therefore, for the speedy organisation of a Forest Department at Home which should make forestry as intensive as cultivation has now become in the country. An eye should also be kept on the growth of timber consumption *per capita*, and it is surprising that this question has not so far been discussed with the same concern as the one bearing upon the conservation of our coal supplies. It is satisfactory at least to learn that the Board now proposes in the first instance to collect information and make surveys and next to secure land for commercial planting in typical districts where there is a large area of uncultivated land, and where a *primâ facie* case for afforestation has been established.—[*Indian Engineering.*]

WORLD'S LARGRST TREE TRUNK.

The giant tule tree which stands in the little churchyard at Mitla, Mexico, is an object of interest to many tourists. It is said to have the largest trunk of any tree in the world. Its circumference at its largest point measures 145 feet and 2 inches. So large is this trunk that a full grown man when standing by it appears to be of insignificant size. The ancient tree is greatly reverenced by the native of that part of Mexico. In passing beneath its overspreading branches these simple-minded people never fail to tarry a moment and pay quiet devotion to the great monument of nature.

The age of this tree is a matter of conjecture. It is said to be no larger now than when it was first discovered by the Spanish hosts which followed Hernando Cortez to the shore of Mexico nearly four centuries ago, says the *American Lumberman*. According to the theory of some scientists the tree has been silent witness to several different civilisations. Within its shadow, almost are the prehistoric ruins of Mitla, which are of never-failing interest to all archæologists. To the romantic mind may be pictured the scene of this giant tree looking down upon the prehistoric people as they builded the great structures which now stand in ruins at its very feet. The tree bids fair to stand through coming centuries and, perhaps, witness other changes in the human progress of events of as great moment as those which it has already passed through.—[*American Forestry.*]

KAPOK.

A bulletin on Kapok, issued by the Philippine Bureau of Agriculture, gives the following description of the tree and its uses, quoting in part from Mr. E. D. Merrill, botanist of the Philippine Bureau of Science :—" The kapok tree (*Ceiba pentandra*, Gærtr., or *Eriodendron anfractuosum*, DC.), family Bombaceæ, is a slender deciduous tree 50 feet or less in height, the trunk cylindric, usually with a pyramidal, stout, short, scattered spines, the branches horizontal, in distant whorls, giving the tree a very characteristic

appearance. The fruit is an oblong, 5-celled, 5-valved, pendulous capsule about 6 inches long and 2 inches thick, glabrous outside and silky inside, the seeds globose, black, numerous, completely surrounded by abundant, white or somewhat brownish, long, shining silky hairs, the kapok of commerce. In tropical America the remaining eight species of the genus Ceiba are also known, but their product is generally believed to be inferior to the true kapok. About 45 or 50 other species yielding a somewhat similar but decidedly inferior floss occur in the allied genus Bombax. One of them is said to be native to Africa, 5 or 6 to the East Indies and tropical Australia, and the rest to tropical America. There appears to be a tendency to use the term 'Kapok' for designating the products of the allied species of Ceiba and Bombax, instead of restricting it to the particular product of the true kapok tree (*Ceiba pentandra*). The terms 'silk cotton' and 'tree cotton' are also commonly used to denote the floss on both the Ceiba and the Bombax species, but they should not be applied to the true kapok. Until recently kapok was considered unsuitable for textile purposes, for owing to its shortness and brittleness, it could not be spun into yarn. But according to recent reports, a process for spinning the fibre into yarn has finally been discovered by Prof. Goldberg, of Chemnitz, Germany. Yarn of a fine quality is said to have been spun from it. The principal use of kapok, however, is for filling pillows, cushions, mattresses, bandages, and life-saving appliances. Kapok does not get matted with use, as is the case with all other filling materials. The use of kapok in the United States for life-saving appliances was restricted to the Java product until 1912, when Philippine kapok was shown to meet the requirements." An oil is manufactured from kapok seed and the residue, which is said to contain about 5 per cent. of nitrogen, is used as a fertiliser.—[*Indian Trade Journal.*]

ACZOL, A NEW TIMBER PRESERVATIVE.

Aczol, one of the new timber preservatives claimed to have great effectiveness and durability, consists of metallic ammoniates mixed with an antiseptic acid containing phenols and naphthalenes. The commercial product, containing 15 to 20 per cent. of reinforced phenols and the equivalent of 30 per cent. of copper and zinc salts, is estimated to have 150 times the strength necessary for complete sterilisation, and, as the powerful compounds are permanently fixed only a very dilute solution is required. Painting with a one in five solution in water may be useful for some timber that is to be buried or exposed to the weather. Impregnation is better, and is essential in the case of telegraph poles, and simply requires immersion in cold solution for two or three weeks, with pressure if it is desired to shorten the treatment. Besides penetrating the wood, the liquid has some solvent effect on the cellulose, resulting in an impermeable surface coating. The wood is not made appreciably heavier, loses nothing in insulating value, but is materially strengthened, and can be painted or polished. With suitably regulated strength of solution, it is made water-proof or flame-proof.—[*Capital.*]

THE COST OF CAMPHOR.

In a most interesting paper the editor of the *Journal of Tropical Medicine and Hygiene* describes the astounding conditions in which camphor is obtained in the Island of Formosa, the principal source of the world's supply of this pungent drug :—

"It appears that the camphor tree grows only in the most mountainous parts of Formosa, inhabited by head-hunting savages, whom none of the successive invaders of the island have been able to subdue. These savages are quite alive to the value of the trees, and fiercely oppose all attempts to get possession of the forests. Since the Japanese took the island after their successful campaign against China in the nineties, they have been carrying on a carefully-conceived plan of gradual penetration. They make paths six feet in width through the virgin forests, every 120 yards

stands a guard-house, and every fourth or fifth guard-house is a small fort entrenched and defended by wire entanglements. Telephonic inter-communication, machine guns, and all the resources of Western military science are employed, and the lines are pushed gradually forward. In spite of these elaborate precautions, the loss among the camphor gatherers amounts to hundreds of deaths annually.

"It is calculated that Formosa contains about one million camphor trees, some ten thousand of which are cut down every year. At this rate the supply will be exhausted in a hundred years; but when the country is thoroughly pacified there is no doubt that the Japanese will see that reafforestation is properly undertaken and an inexhaustible supply ensured. The savages are estimated to number about 120,000; and a further twelve years will, it is thought, be required to subdue them. He concludes that the popular saying as to every particle of camphor having cost its weight in blood has some measures of justification. Next time the institutional physician orders compound tincture of camphor in a cough mixture, let him reflect on this!" says the *Hospital*.—[*Indian Agriculturist.*]

MANUFACTURE OF WOOD-PULP IN THE PUNJAB.

We understand that an agreement has been entered into between the Secretary of State for India in Council and Mr. T. J. Sullivan of Calcutta, whereby the latter has been granted a license to fell and utilise spruce and silver-fir trees in the forest lands of the Kulu Forest Division (excluding the outer. Seoraj Forest) for the purpose of making wood-pulp. The license will be for two years with power to renew for another year. The licensee will, during this period of three years, erect and equip a wood-pulping factory on the Upper Bari Doab Canal capable of turning out not less than 3,000 tons of pulp per annum, and he also undertakes to fell yearly not less than 1,500 spruce and silver-fir trees for which he will pay at the rate of Rs. 2 for a first class and Re. 1 for a second class tree. On the other hand, the Secretary

of State in Council agrees to grant to the licensee the necessary water power on the Upper Bari Doab Canal at an annual rental and to lease to the licensee a suitable site for the factory. If at the end of the license period, *i.e.*, three years, everything is satisfactory, and each party to the license has fulfilled all obligations and promises, then the Secretary of State will grant to the licensee a lease for 20 years, during which period in addition to enjoying all the rights and privileges which he enjoyed during the period of the license, he will be granted the first refusal of the Bushahr leased forest lands for a period of seven years. In the event of the lease-holder taking up this increased area he will be given water power to be supplied from the Sirhind Canal and granted leave to cut up to 10,000 trees annually in the Kulu and Bushahr forests. These additional facilities will, however, only be granted subject to provisions which have been made for safeguarding the interests of Government by increasing the royalties which will be payable by the lease-holder.—[*Indian Agriculturist.*]

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NOTES ON THE TWISTED FIBRE IN CHIR PINE.

BY E. A. SMYTHIES, I.F.S.

One of the most striking characteristics of extensive areas of chir pine forest in Kumaun is the prevalence of twisted fibre. This phenomenon is so wide-spread, so unexpected, and so curious, that it arrests the notice of every observer, and every imaginable cause has been suggested to account for it. Heredity, climate, altitude, wind-pressure, aspect, soil, fire, grazing, lopping, all these and many other causes the writer has heard suggested. One ingenious Ranger possibly with dim memories of lectures on heliotropism suggested that the light-demanding nature of the tree caused it to twist round, following the sun in its daily path across the heavens.

2. Mr. Hearle, 20 years ago, in the Ranikhet Working-Plan, noted "it would seem as if this curious phenomenon was due to poverty of soil, lowness of altitude and unfavourable aspects combined." As, however, it is found on many sorts of soil, at every altitude and on every aspect, this explanation is inadequate. So far as the writer knows, no systematic attempt has been made to

arrive at the cause of this defect nor have any proposals been made to minimise its occurrence in future, or ameliorate its intensity.

3. That the matter is of considerable practical importance the following extracts from the Forest Administration Report in the United Provinces, 1913-14, will show :—"The defect of twisted fibre in the chir timber in this Circle (*i.e.*, the Kumaun Circle) has been mentioned in many reports. In selecting sleepers for antiseptic treatment, 17 per cent. were rejected for this defect. In the Almora district it is probably not an exaggeration to say that in one-half of the area of chir forests, the trees are more or less affected. The cause of this defect is not yet known and now requires investigation without delay, as it may affect the treatment required for these forests, which will be laid down in the Working-Plans shortly to be commenced."

A perusal of the above extract has emboldened the writer to record his observations on this phenomenon which have gradually accumulated during a sojourn of over five years in some of the worst twisted areas in Kumaun.

4. A systematic examination of this phenomenon necessitates a division of the subject into two heads, *i.e.*,—

(*a*) a description of the characteristics and occurrence of trees with twisted fibre, and

(*b*) an analysis of the possible and probable causes of twisted fibre.

Subsequently it may be possible to arrive at some conclusion as regards remedial or preventive measures, to minimise its occurrence in the future crop.

5. In a twisted-fibred tree, as the name implies, the fibres instead of running vertically up the trunk, run like a corkscrew round the trunk. Almost invariably the twist is from right to left, although occasionally trees with twist from left to right are met with. Every degree of twist is found, from trees in which it is so slight that it is scarcely noticeable, to intensely twisted trees, in which a *vertical* cut a foot long girdles or severs all the fibres in a tree of 6′ girth. Trees of such severe twist are usually bulbous or swollen at the base, the fibres in the 'bulb' running practically

horizontal, and gradually toning down to an angle of 45° or so where the stem proper begins. In such trees the twist is carried into the branches, and they frequently present the most bizarre and fantastic contortions, both the main stem and the branches forming amazing knots. One might imagine the trees were writhing in perpetual and awful agony.

6. Trees with an appreciable amount of twist cannot be utilised for sawing up into planks or sleepers, twisted poles are utilised to a certain extent by right-holding villagers, but the chronic variety cannot even be split into billets of firewood, and is useless to man and beast. To this fact probably such trees owe their existence, since the survival of the unfittest (for use) has been the rule for many ages.

7. Apart from trees which are obviously twisted, there is a disconcerting aspect of this phenomenon in trees, which to all outward appearances are splendid straight grown trees, but internally are twisted hypocrites. Three years ago, when there was a big demand for sleepers, a contractor applied for some trees from a block in the valley of the Kosi river, which had never been exploited. Many of the trees in this block were obviously twisted, but many appeared magnificent specimens, with tall, straight cylindrical boles, of large girth. The writer personally marked the trees, and to give the experiment a fair trial, picked out the finest trees available, every tree taken the contractor himself approved as straight grown. In due course the sleepers obtained were inspected. Undoubtedly 75 per cent. would have been rejected for antiseptic treatment, while not less than 10 per cent. had actually broken across in seasoning! many of the trees had proved to be twisted inside, with an outer ring of practically straight-grained fibre.

8. This leads to the mention of a common characteristic amongst slightly and moderately twisted trees. They appear to tend, as they grow older, to outgrow the twist, or at least to twist less intensely. Chir poles may often be seen with decided twist in the lowest 3′ or 4′ of their bole, and with very little sign of twist above. Similarly in larger trees which have broken

and show a jagged fracture, there is often an internal core in which the broken fibres can be seen to twist, while the outer broken fibres point straight upwards.

9. In areas of intense twist, every tree in the forest will be twisted. In areas of slight twist scattered trees of perfectly straight grain may be found, while in areas of straight grain, scattered twisted trees will be found. The latter are undoubtedly and unfortunately more common than was at first anticipated, and what is to be done with them in commercial working will be rather a problem.

10. To consider the distribution of twisted fibre. The tertiary Siwalik sandstones of the outer hills are practically free of twist, and the silurian quartzites and dolomites of the Naini Tal hills are comparatively so, only occasional twisted trees being met with. The granites and granitic gneiss of Eastern Almora may also be classed as fairly free, while the mica schists around Almora are essentially the home of twisted fibre.

Southern and western aspects are usually more "twisty" than northern and eastern aspects, while the intensity of twist almost invariably increases as we approach villages.

Altitude has apparently little to do with it, except in so far that lower altitudes are often nearer villages.

11. The above remarks are fairly well established generalities, but—and this is where the difficulties begin—well-marked exceptions to any of these generalities are frequently met with. The very typical mica schist soils around Ranikhet, for example, have forests remarkably free from twist. In a block near Almora (Siahidevi II), on a granite soil, and N. and E. aspect, at an altitude of 6,000′—6,500′, the chir forest shows intense twist. There is no use in multiplying instances of further exceptions, it will suffice to repeat that they are frequent, and of a baffling nature.

12. Let us now examine the possible and probable causes of this phenomenon.

To commence with Heredity, which is often suggested as the cause of twist. Four years ago, the writer had some seed collected from trees with intense twist, which were surrounded by twisted

regeneration, and this seed was sown in beds in the Chaubattia nursery. *Without exception the seedlings came up with no indication of twist whatsoever.* This experiment has been twice carried out with the same result, and shows that twisted fibre is essentially not hereditary, but an acquired character.

Circumstantial evidence to the same effect is given by the Almora plantations. The seed sown must almost inevitably have been obtained from twisted trees (since there are no straight-grained trees for many miles around), but the young plants are growing up on the whole decidedly free of twist.

Surely this is a very important point established. It will tend to modify our treatment of twisted areas, and gives us our first glimmer of hope for these at present useless forests.

13. Climate and wind-pressure have evidently very little to do with it. Otherwise we should not get—as we often do—forests with straight and twisted trees growing in an intimate mixture.

14. Soil and aspect, although possibly not primary causes, are undoubtedly predisposing factors causing twisted fibre. That is to say, forests which under certain treatment might grow up straight-grained on favourable soils and aspects, with the same treatment might grow up twisted on unfavourable soils and aspects.

15. *Fire.*—A note of Mr. Canning's in the Kumaun Circle Annual Report, 1913-14, is very much to the point:—"If burnt over, one year old seedlings are generally killed outright, and older ones die back to near the ground level, and send out a new shoot, developing a swollen carroty base. The fibres of the wood in the centre of these swollen (bulbous) bases are *always twisted.*

This twist appears to be generally continued in the upper parts of such young plants although it is less marked. The dying back of seedlings, whether occasioned by fire or otherwise, appears likely to be one of the causes of twisted fibre in this Circle, but it does not explain the local description of this defect."

The writer corroborates every word of this note. There is further evidence to bear on this point. In some private estates (at Kausani), there were originally some very fine chir forests in

which possibly 30 per cent. of the trees showed twisted fibre. These forests have been burnt annually for years past, despite which a thick crop of young chir plants has come up. But in this young crop, *the proportion of twist is* 100 *per cent.* This establishes that *fire is a primary cause.*

16. Fire, however, is not the only primary cause. If it was, the regeneration in all our fire-protected forests should be coming up straight-grained, whereas in the *neighbourhood of villages*, and where grazing is heavy, a certain portion is still coming up twisted. Cattle in these hills are frequently only taken a short way from the villages, and as we get out of the range of the cattle, the generation loses its tendency to twist. Here then is another primary cause established.

To put the matter in a nutshell, the primary causes may be included in the expression "Damage during youth." In the writer's opinion, a primary cause combined with predisposing factors,—in other words, *Damage during youth in unfavourable localities*—is the fundamental reason of twisted fibre in the chir forests of Kumaun. It is undoubtedly a fact that twisted fibre is acquired at a very young stage of development, since damage to an old tree or pole does not produce twist, nor is it inherent in the seed.

17. This combination theory at least helps to explain the local distribution of this defect to a considerable extent. It should also be noted that excessive or repeated damage during the seedling stage alone, even on good localities is sufficient to cause twist, and also plants growing on pure rock or exceptionally impoverished soil, even if they have not been damaged, are liable to twist.

18. The conclusions we may draw from this are :—

Careful protection of all regeneration areas, especially from fire, grazing, and removal of humus will to a great extent eliminate or reduce the intensity of twisted fibre.

If we combine with this treatment the subsequent removal in thinnings of such twisted saplings as may come up, we may expect the future crop to be at least commercially exploitable.

The chir plantations around Almora are a standing proof of this. These were started in 1875, and sowings were carried on

from time to time over about 1,000 acres. They were protected from fire and grazing and removal of litter was absolutely prohibited. Grass-cutting has however been allowed.

There are a few scattered old stunted trees surviving, with intensely twisted fibre, showing what the growth would have been without protection. The young crop, although originally the quality of the locality was as bad as it could be, is on the whole distinctly straight grown, or with very slight twist.

It is only on some of the ridges, with bare rock and no soil that twisted fibre is at all noticeable. Coincident with the protection from fire, grazing, and removal of litter, the quality of the soil has of course been greatly improved.

If the Forest Department is given a free hand to introduce similar protective measures, we may await with confidence the time when careful management will have eliminated or at least considerably reduced the pernicious phenomenon of twisted fibre in the chir forests of Kumaun.

ON SOME FOREST MATTERS.

BY C. E. C. FISCHER, I.F.S.

Probably many forest officers have been perplexed, like myself, by some of the prescriptions met with in certain plans and working schemes. I hope I may be allowed to ventilate one or two in the *Indian Forester* with the object of securing their justification or elimination.

1. *Standards in coppice areas.*—We were taught in Europe that, besides other advantages, standards are necessary to provide shade and to ensure a proportion of seedling regeneration, since the old root-stocks cannot go on for ever. Now, in many cases in this country, neither of these two reasons seems to hold good. Frequently, such standards as can be secured are so poor that the shade afforded is negligible and very soon would be more than compensated for by the shade from coppice-shoots that their felling would stimulate.

As regards seedlings, I believe that if any come up at all and survive they are so few as to make no practical difference. My Conservator, early in my service, informed me that in the tropics coppice-shoots springing from near the ground-level soon form their own roots and cast free from the old stock. Nothing that I have observed since has caused me to doubt this statement. However, as I have never seen any definite confirmation of this theory, supported by either experiment or other incontrovertible proof, I should be glad to learn whether it can be demonstrated to be either true or false. its truth is admitted the *raison d'être* of standards from that point of view disappears.

There remain, of course, certain other advantages, such as the provision of timber and agricultural implements.

Several factors demand consideration. If the area under working is the sole source of timber, it may be necessary to retain standards, but even then it may be questioned whether the dual object of supplying small timber and fuel will not be more satisfactorily met by lengthening the rotation and working the area as high forest.

It is fairly certain that most of our coppice-with-standards areas in Southern India yield very inferior timber and that the yield of fuel is directly affected by the preservation of standards. If timber can be obtained from elsewhere and fuel can be made the sole object of the working, then I would postulate that the simple coppice method meets the requirements better, besides being preferable on other grounds to be mentioned later.

In the Madras Presidency nearly all our fuel-yielding forests are in the vicinity of towns or large villages. Consequently, they have been greatly abused in the past (often still are), with the result that the Forest Department has come into a more or less ruined property, sadly hacked about, the least useful species predominating because they were the least tampered with. In such areas there are no stems really fit for standards, but, as the prescriptions of the working-plans provide a definite number of standards, these have to be found, and in many cases the trees selected present a piteous spectacle when the rest of the growth

has been cut back. The reservation of standards affects the quantity and value of the yield very seriously, for the valueless species (many not even used for fuel) predominate and standards must be selected from the few better species available, leaving little utilisable material for extraction. (I have in my mind's eye certain coupes where *at least* fifty per cent. of the present growing stock consists of *Euphorbia antiquorum*, of which the bark alone is used in small quantities for lime-burning.)

With proper working and protection, however, the coppice regrowth will be far superior to the existing stock, and after one or two rotations it may be possible to select some of the best shoots for eventual standards, if found desirable, removing all the other shoots from the same stumps at an early age.

Working with simple coppice would prove advantageous in certain directions, in the existing conditions of staff in regard to its quantity and quality. Working and control would be simplified, and there would be fewer points on which the executive officers could go wrong. A great deal of trouble and friction would be avoided. Standards are constantly broken or felled during working, whether the coupe is worked departmentally or by a contractor, needing enquiry, punishment and fine, with the resulting petitions and recriminations. Freed from the incubus of the standard more attention could be paid to the regular cutting, cleaning and weeding, the want of which is more often suffered than remedied.

I do not wish to be misunderstood and in advocating pure coppice I desire to make it clear that I refer only to such cases where a yield of material other than fuel is not essential.

2. *Climber-cutting.*—In the prescriptions for the cutting of climbers one often finds the injunction that they must be cut in two places. The necessity for this double operation is not clear to me. It is just possible that if the two surfaces of a cut are left in close juxtaposition they may grow together again, but normally they fall apart owing to released tension. Further, it is conceivable that if the upper portion of the cut stem is allowed to rest on the ground it will throw out roots. To obviate these

possibilities, however, it would seem to be sufficient to prescribe that the cut be so made as to preclude them. The double labour and cost (no small matter with large climbers a foot or more in diameter—*Bauhinia* and *Spatholobus*—or with the hard-wooded *Zizyphus*) seem to be quite unjustifiable.

3. *Subsidiary results of fire-protection.*—Is there any evidence to show that grass ticks increase in fire-protected areas? It seems reasonable to believe that they do and certainly they are so numerous and troublesome in some protected areas I have had to work in as to become a serious inconvenience. This may seem a trivial matter to those who are unacquainted with these pests, but those who have suffered the weeks of subsequent irritaation caused by their attacks will agree with me. It would be curious if fire-protection had to be discontinued on this account, a conceivable eventuality when it is considered that there is every possibility of ticks being conveyors of disease.

SOME NOTES ON THE REGENERATION OF *IN* AND *KANYIN* IN AN UPPER BURMA DIVISION.

BY H. R. BLANFORD, I.F.S.

As very little is yet known of the sylviculture of some of the more important of the unreserved species in Burma, the following notes may be of some interest, especially as they suggest a possible system of management that may be adopted for " In " (*Dipterocarpus tuberculatus*) and " Kanyin " (*D. turbinatus*) owing to the very general flowering of " tinwa " (*Cephalostachyum pergracile*) in the southern portion of the Division during the rains of 1913, fire-protection in the reserves affected was given up and these areas were burnt in the hot weather of 1914, in many cases for the first time in some 15 years. This burning was made to reduce the subsequent growth of young " tinwa," remove débris and in other ways assist the natural regeneration of teak. In June after this burning when inspecting one of these reserves, the research officer for Burma, who was with me at the time, drew my attention to the

fact that all the young "Kanyin" up to about 10 feet in height had been killed by the fire.

The "Kanyin" regeneration was exceedingly good forming dense thickets and had obviously flourished under fire-protection, but had been entirely unable to withstand the fire. Outside the fire-trace, where there was sufficient light "Kanyin" seeds, which had fallen shortly before, were found to be germinating freely. I have since then visited several of these reserves, which contain good "Kanyin" forest and have found the same case everywhere. Occasionally where the fire has not been very fierce only trees up to 4 or 5 feet high have been killed, but the lower branches of the taller trees up to the same height have all been killed and the dead leaves are still (December) hanging on these branches. Above the height to which the fire reached, new shoots have been put on and the larger saplings have recovered. Another point that is worth noticing is that unlike teak which, when burnt back, sends up a fresh shoot from the roots, "Kanyin" appears to be killed entirely if its leading shoot is burnt. Judging from the size of much of the "Kanyin" regeneration I should say that it has originated since fire-protection was commenced, but there seems no doubt from the very free germination taking place on the burnt ground that "Kanyin" seed in common with the seed of most other species germinates more freely in areas which have been burnt. "Kanyin" seed does not fall until the end of May or beginning of June. By that time the forests have of course been burnt so that fire does not touch the seed, but no doubt ground that has been burnt over forms a more suitable germinating bed than when covered with a thick layer of dead leaves as in fire-protected areas. It would appear that seeds germinate immediately on falling and do not, as in the case of teak, remain fertile in the ground for several seasons.

From the above the following conclusions as to the system of management to be adopted may be drawn :—

1. That a heavy clearing of all cover with the retention of sufficient "Kanyin" seed-bearers and a burning in the following hot weather will probably give abundant regeneration.

2. That after the first burning strict fire-protection must be undertaken.

This method may be suitable in forest where "Kanyin" only has to be considered, but teak and "Kanyin" are frequently found growing together, and although I have only occasionally seen teak growing to a large girth alongside giant "Kanyin," good teak forest often merges into good "Kanyin" forest on the higher slopes (and also on the level near streams), and the two types of forest are often so closely connected that it is impossible in many places to consider them separately. In treating these forests, therefore, the first consideration must be for the teak and for this fire-resisting species (as it undoubtedly is in comparison with almost any other), the method to be applied is somewhat different to that outlined above for "Kanyin." In the first place teak seed does not germinate with the same readiness as "Kanyin," and in the second place benefits in its struggle for existence with other species by repeated burning.

The general scheme for working teak forests in the Division is to select areas suitable for improvement felling and abandon fire-protection until the first heavy improvement felling has been done. On completion of this the area is burnt for the last time and thereafter fire-protected. In working in accessible localities where there is good "Kanyin," it would therefore be possible to make the heavy clearing of cover in the "Kanyin" forest at the same time as the first improvement felling is made in the teak forest. A final burning would be made before the "Kanyin" seed of the year fall and thereafter the "Kanyin" regeneration would be fire-protected and assisted by supplementary improvement fellings in common with the teak-bearing area.

On turning to "Kanyin's" close relation the "In" we find matters somewhat different. In the first place "In" forests are characteristic. They consist usually of nearly pure "In" and except for "Ingyin" (*Pentacme suavis*), the sylviculture of which is probably very simliar to "In," are rarely associated with any other species of much value. Certainly the stray teak that are occasionally found on the edge of "In" forest may be put down as worthless.

In contrast to "Kanyin" "In" regeneration seems to thrive in areas burnt over annually. The seed falls somewhat earlier than "Kanyin," but burning in the drier "In" forests is also earlier. The seed like "Kanyin" germinates immediately. In that part of the Division east of the Irrawaddy there are some excellent "In" forests which, especially near the river, have been heavily worked. As a general rule the forest in these worked areas now consists of almost pure "In" pole forest. These forests are burnt annually and "In" seems not only able to withstand the fire well but also, when burnt back, to send up a new shoot from the root. The thicker bark of the "In" no doubt accounts partly for its ability to resist fire better than the "Kanyin" and possibly the same reason may be given for the extra hardiness of the root. Another reason for the ability to send up fresh shoots from the roots may be that "In" grows in much drier localities than "Kanyin" and has therefore to send down a longer root to obtain its nourishment. This root is naturally better able to withstand fire. In any case the method of working "In" forest is considerably simplified by these characters. It should be possible to treat "In" by the regular method of successive fellings, sufficient seed-bearers being left until natural regeneration is assured. Fire-protection will not be necessary nor will it be necessary to modify the method adopted in the interests of more valuable species.

MIXED IMPREGNATION WITH OILS.

Note on the treatment of Terminalia tomentosa *broad gauge sleepers at Shahpur in the Betul District, Berar Circle, by open tank treatment in* 33 *per cent. of* " Solignum " *and* 67 *per cent.* Liquid Fuel Oil.

BY R. S. PEARSON, I.F.S., FOREST ECONOMIST.

1. The work was started by the writer, and completed by Museum Assistant, Gyan Singh, in November 1914.

2. The sleepers were felled in the working season of 1913-14 and stacked to season for 16 to 18 months ; the felling and conversion was carried out by the Divisional Forest Officer, Betul.

3. The object of the experiment was to introduce 9 to 10 lbs. of "Solignum" and Earth or Liquid Fuel Oil into the sleepers. To do this an attempt was made in February 1914, but as the sleepers at that time were not sufficiently seasoned, the treatment had to be postponed for 8 months, when it was found that the required absorption was obtained by heating for 3 hours to about 90° C. and the sleepers and oil allowed to cool down for a further 21 hours.

4. To arrive at the amount of oil absorbed 25 per cent. of the sleepers were weighed before and after treatment. Detailed results are given in statements 1 to 6 attached to this note. The average absorption per sleeper of 114 sleepers by heating to 90° C. maximum temperature and the temperature of the oil dropping to about 50° C. in 24 hours was 9·87 lbs. per B. G. sleeper.

5. The chief point of interest is the regularity of absorption of each sleeper, in spite of some of the sleepers containing a small percentage of sap-wood, in the case of Chir sleepers, for instance, the absorption is generally much more irregular.

6. The cost of "Solignum" is Rs. 3 per gallon of 10 lbs., that of Liquid Fuel Oil 4 annas per gallon; so that the cost of a gallon of the mixture comes to Re. 1-2-8. The cost of handling per sleeper may be put at one anna, which being the cost of treating a B. G. sleeper with 10 lbs. of oils amounts to Re. 1-3-8. This is possibly a little high, so that to work on commercial lines it would be necessary to reduce the mixture of oil to 25 per cent. Solignum and 75 per cent. Liquid Fuel, thus reducing the cost of treating a B. G. sleeper to Re. 1 including handling, etc.

7. All the sleepers have been branded with the mark T. T./ S. L. F. on each side, and arrangements are being made to hand them over to the Great Indian Peninsula Railway for laying in the line.

Detailed statements showing the degree of absorption are attached.

STATEMENT No. 1.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serial No.	Weight before treatment in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
1	198	206	8	Maximum temperature of oil 89° C. falling to 49° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for a further period of 21 hours while the oil cooled down.
2	252	259	7		
3	189	199	10		
4	204	213	9		
5	187	196	9		
6	217	225	8		
7	203	213	10		
8	187	197	10		
9	200	208	8		
10	193	201	8		
11	194	205	9		
12	186	199	13		
13	204	214	10		
14	222	230	8		
15	206	218	12		
16	194	216	22		
17	182	195	13		
18	191	200	9		
19	208	217	9		
		Total ...	192		
Average absorption per B. G. sleeper ...			10·1		

STATEMENT No. 2.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serial No.	Weight before treatment in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
20	225	228	3	Maximum temperature of oil 90° C. falling to 51° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for a further period of 21 hours while the oil cooled down.
21	193	203	10		
22	195	204	9		
23	203	210	7		
24	201	228	27		
25	193	204	11		
26	190	197	7		
27	224	231	7		
28	176	186	10		
29	242	250	8		
30	217	225	8		
31	180	188	8		
32	211	219	8		
33	221	228	7		
34	191	205	14		
35	177	189	12		
36	187	196	9		
37	201	213	12		
38	199	205	6		
39	205	210	5		
		Total ...	188		
Average absorption per B G. sleeper ...			9·4		

STATEMENT No. 3.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serial No.	Weight before treatment in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
40	184	195	11	Maximum temperature of oil 90° C. falling to 50° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for further period of 21 hours while the oil cooled down.
41	182	191	9		
42	215	222	7		
43	197	203	6		
44	205	213	8		
45	191	198	7		
46	178	189	11		
47	156	162	6		
48	205	213	8		
49	177	190	13		
50	217	226	9		
51	181	190	9		
52	193	203	10		
53	203	210	7		
54	156	165	9		
55	175	187	12		
56	200	210	10		
57	201	208	7		
58	188	198	10		
59	213	223	10		
		Total ...	179		
Average absorption per B. G. sleeper ...			8·95		

STATEMENT No. 4.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serial No.	Weight before treatment in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
60	201	211	10	Maximum temperature of oil 90° C. falling to 53° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for a further period of 21 hours while the oil cooled down.
61	211	224	13		
62	158	172	14		
63	170	181	11		
64	160	169	9		
65	176	184	8		
66	180	194	14		
67	187	200	13		
68	198	205	7		
69	202	210	8		
70	206	216	10		
71	209	220	11		
72	155	170	15		
73	204	214	10		
74	171	177	6		
75	195	206	11		
76	185	193	8		
77	177	183	6		
78	190	199	9		
79	186	199	13		
		Total ...	206		
Average absorption per B. G. sleeper ...			10·3		

STATEMENT No. 5.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serial No.	Weight before treatment. in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
80	183	191	8	Maximum temperature of oil 90° C. falling to 51° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for a further period of 21 hours while the oil cooled down.
81	210	221	11		
82	189	202	13		
83	195	206	11		
84	182	191	9		
85	207	216	9		
86	212	218	6		
87	194	202	8		
88	211	220	9		
89	215	225	10		
90	215	222	7		
91	206	214	8		
92	190	199	9		
93	199	210	11		
94	192	202	10		
95	194	205	11		
96	210	220	10		
97	187	195	8		
98	180	188	8		
99	206	215	9		
		Total ...	185		
Average absorption per B. G. sleeper ...			9·25		

STATEMENT No. 6.

Sain (Terminalia tomentosa) *sleepers treated at Shahpur, C. P.*

Serail No.	Weight before treatment in lbs.	Weight after treatment in lbs.	Difference in lbs.	Temperature.	REMARKS.
100	168	179	11	Maximum temperature of oil 90° C falling to 45° C.	Total period of immersion, 24 hours. Heated for 3 hours and the sleepers allowed to remain in the oil for a further period of 21 hours while the oil cooled down.
101	170	182	12		
102	197	203	6		
103	212	220	8		
104	217	224	7		
105	201	213	12		
106	192	206	14		
107	198	206	8		
108	167	180	13		
109	166	175	9		
110	200	208	8		
111	221	230	9		
112	175	187	12		
113	191	201	10		
114	187	200	13		
115	190	200	10		
116	221	228	7		
117	207	216	9		
118	175	195	20		
119	176	190	14		
		Total ...	212		
Average absorption per B. G. sleeper ..			10·6		

EXTRACTS.

FOREST GUARDS AND INFERIOR SERVICE.

We publish below copy of a letter addressed by the Government of India to all Local Governments, etc., in connection with the above:—

"I am directed to invite a reference to my Circular letter No. 6-F-146-2, dated the 27th April 1914, communicating the sanction of the Secretary of State to a proposal to class as superior the service of such grades of Forest Guards on pay exceeding Rs. 10 a month as may be specified by the Local Governments and Administrations concerned to whose discretion it has been left to bring the change into force when it is considered desirable to do so.

2. It has since been brought to the notice of the Government of India that, in the absence of orders to the contrary, the specification as superior of the service of certain grades of Forest Guards would carry with it the right to draw the travelling allowance admissible to officers of the third class under article 1002 of the Civil Service Regulations. As this result was not intended a note is being added to article 1002 to the effect that all Forest Guards, whatever their status may be as regards pension, are inferior servants for the purpose of the travelling allowance rules."

THE PRODUCTION OF PAPER FROM BAMBOO.

For some time past important experiments have been conducted by Mr. James L. Jardine, of Esk Mills, Penicuik, in the manufacture of paper from bamboo. The results have proved highly successful, and the process has been patented by Mr. Jardine, in conjunction with Mr. Thomas A. Nelson, of Parkside Works, Edinburgh. Mr. Jardine has introduced a modification of the bisulphite process, and has succeeded in producing an easy-bleaching pulp from bamboo. The invention practically consists in cooking the decorticated material in a digester with a

solution of magnesium or sodium bisulphite, or an acid sulphite with a surplus of available SO_2 and completely removing from the liquid in the digester the gases liberated in the course of cooking. We learn that paper has been manufactured on a commercial basis with the most satisfactory results, and Mr. Jardine is to be congratulated on the successful issue of his experiments.—[*The World's Paper Trade Review.*]

We admit that we are somewhat surprised at the above as we imagined that the pectose contained in bamboos and grasses does not yield readily to the sulphite reatment. In a tropical climate, such as India, the question of producing sulphite liquor must be one of difficulty. The gas in the liquor is very volatile and the success of the process of digestion depends largely on keeping the temperature of the gas and water low enough to ensure absorption.—*Hon. Ed.*

DRYING UP OF SOIL.

The alarming decrease in the fertility of stock-growing areas of South Africa has been attributed to soil erosion from natural, non-preventible desiccation of the country. At a late meeting of scientific agriculturists, a different view was expressed, and it was held that the cause of the growing sterility is the destruction of the grass that binds the soil into a water-retaining mass that absorbs rain and prevents its rapid run-off. The grass has been destroyed, it is believed, by indiscriminate burning and by the continual driving of cattle along natural hollows. In every instance of the drying up of valleys, a small stream seems to have formed, and then gradually enlarged into a large river.—[*Capital.*]

FORESTS, STREAM-FLOW AND RAINFALL.

An interesting case has occurred affording practical demonstration of what has long been argued in an academic way by engineers. In Idaho, U. S., a forest fire four years ago burnt out the watershed supplying water to the city of Wallace. The stream both supplied the water for the city and operated an electric plant. Since the loss of the forest the flow of the stream has become irregular, the minimum having fallen to 25 per cent. below the minimum formerly noted. The electric plant has also

been affected by the discharge often falling below that necessary for operation, thus necessitating frequent resort to the reserve steam plant. Meanwhile rainfall observations have shown the fall continues to be normal. The case has proved that the loss of forest has not affected the rainfall, but has conduced to irregular run-off; that is, there is no longer conservation of water during a dry period and gradual discharge of it from the forest area to the stream. It will be remembered that most writers have contended that forest does increase rainfall and this case would seem to disprove it. On the other hand, no one, we think, has ever maintained that the effects are felt on a small area of forest. Whether when a very wide area of forest has been denuded rainfall diminishes remains to be proved, and we hope will be proved some day. That forest denudation affects the regularity of stream-flow has been more generally accepted as correct, and we are glad to see that in the case of the city of Wallace practical effect is to be given to the belief by re-afforesting the burnt-out area.—[*Indian Engineering.*]

WAR AND WOOD-PULP.

It is not only in its effect upon the reading public that the war is keeping the book trade in its present state of suspended animation. The question of the paper supply is obviously a very serious one when so much of the raw material for books comes from abroad in the shape of wood-pulp and esparto. Esparto, a grass from the shores of Spain and Northern Africa, preceded wood as a substitute for rag when the supply of that material proved insufficient to meet the increasing needs of the book market. To-day some 200,000 tons of esparto are imported into England, chiefly for this purpose, esparto being especially applicable to the manufacture of book paper. The war will cause the paper-maker to turn his attention more closely than ever to the discovery of other possible sources of supply. Wood is not an inexhaustible material. The demand for pulp has increased so vastly that it is now estimated to account for the destruction of something like

50,000,000 trees every year. According to Mr. R. W. Sindall, who has made investigations in this connection on behalf of the Indian Government, the most likely substitute for esparto and wood-pulp is bamboo, but experiments are being made with fibrous stock of every description. Meantime the price of paper has gone up, and one of the largest manufacturers for the book trade stated last week that unless fresh supplies of material and chemicals were forthcoming his works would be temporarily shut down before the end of the month. The increase in the price of paper in the book world will naturally fall heaviest of all upon the cheap reprints, especially where these are issued by British houses for Continental editions.—[*Times' Literary Supplement.*]

INDUSTRIAL DEVELOPMENT IN MYSORE.

MATCH AND PENCIL FACTORIES.

The Government of His Highness the Maharaja of Mysore have been considering the desirability of encouraging capitalists and enterprising organisers of capital for establishing paying and useful industries in the State, like paper-manufacturing, match-making, pencil-making and with that end in view employed experts to inspect the raw materials of the State, and to report on their suitability for manufacture and the chances of success if the industries should be started. According to the Bangalore correspondent of *New India,* published at Madras, two Forest officials of the State are now engaged in exploiting Kadur and Shimoga district forests to test the possibilities of starting a *paper manufactory* in Shimoga. Their report is ready and will shortly be published.

Mr. G. C. Evance of Calcutta, Match Expert, was engaged to report on the possibilities of a match factory in the Province. He laboured for some time and recently submitted an interesting pamphlet. From this it is evident that there is every possibility for working successfully a match factory in the Province.

The resources of the State in the mater of match wood are ample and a capitalist can safely be assured of a good dividend on his outlay. Mr. R. S. Troup, of the Imperial Forest Research Institute at Dehra Dun, has discussed at great length the possibi-

lities of Match Industry and *has opined that the wood for matches* requires to be fairly soft and should split easily. It should ignite easily and burn with a flame and when blown out, it should not smoulder. Wood of that description is largely available in the Province.

Rai Bahadur M. Muthanna, Conservator of Forests (since retired), has furnished a list of 20 woods obtainable in the Province, which are suitable for the manufacture of matches, and also gives an estimate of the annual supply likely to be available, their selling rates and the districts where they occur. Shimoga district is considered to be the best place for a match factory. The river Tunga will help considerably in floating timber to the factory. The town of Shimoga is connected by a railway. There is a forest tram-line as well. Mr. Muthanna quotes the selling rate of wood for match manufacture from eight annas to one rupee per cubic foot.

Mr. Troup considers that the highest price which should be paid for wood delivered at the factory is 3 to 5 annas per cubic foot for coloured woods and 7 annas for good white woods and 8 annas for the first quality, and remarks that if a higher price than 8 annas a cubic foot is paid for timber delivered at the factory, a good margin of profit cannot reasonably be expected.

CHOICE OF SITE.

According to Mr. Troup, *the essential conditions of a good* site are—

(1) a sufficient supply of suitable and inexpensive wood in green condition ;

(2) cheap transport from the forests to the factory : water transport is the best ;

(3) cheap transport from the factory to the area of consumption ;

(4) continuous work of the factory all the year round, for which is required either a continuous supply of green timber all the year round or sufficient storage of supply of water for maintaining stock of moist wood when extraction from the forest is suspended for feeding engines. Shimoga has all the facilities.

The Forest Department however, do not seem to be sanguine about guaranteeing any definite supply of wood.

Mr. G. C. Evance, the Match Expert, in his report, dated the 30th March last, remarks that his inspection of forests has satisfied him "that not only is there a very large supply, but this supply is capable of being increased to any extent by judicious management in the matter of felling and re-planting. In Sacre Byle jungle of the Shimoga district, there is a very large supply of *Bombax malabaricum*, one of the woods, I know of, for the manufacture of both boxes and matches. The timber can also be extracted and carted at a reasonable rate from the forest of Shimoga Range. There is in my estimation wood in the Shimoga district and within 15 miles of the town of Shimoga sufficient to supply 300,000 cubic feet per annum. Many of the species have attained a girth of 12 feet. They are in all stages of growth from sapling upwards."

Mr. Evance suggests that the size of the factory for profitable working should be of at least 1,500 gross daily. In his opinion "there is not the least doubt that the Shimoga district is the place to establish a match factory. It is already rich in many suitable varieties of wood, can easily be planted out, so that the supply may be increased to any extent. The timber can also be easily extracted and carted to the rail head at a small cost. Therefore I advise that a factory of 1,500 gross capacity be established there."

Mr. Evance gives the following estimates :—Estimated cost of production : 1,500 boxes of matches per 10 hour day, Rs. 750.

Estimated profit or loss : 1,500 gross matches per 10 hour day, 300 working days per year, Rs. 3,37,500.

Capital required to establish factory producing 1,400 gross boxes of matches per 10 hour working day, Rs. 4,02,200.

He also states where the machinery can be got from. The matter is under the consideration of Government.

It is also stated that excellent possibilities exist for a *Pencil factory* and that the Government are inclined to grant all reasonable concessions to enterprising capitalists.—[*The Indian Trade Journal.*]

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THE UNIFORM SYSTEM IN BURMA.

BY H. C. WALKER, I.F.S.

It has been stated in the *Indian Forester* that with the solitary exception of myself, all the Burma Forest Officers who attended the Conference at Maymyo in 1910, were in favour of the Uniform System. What, however, seems to me very much more important is, that the Inspector-General of Forests in his note on his recent tour in Burma expressed an opinion adverse to the Selection System, and advised more up-to-date methods of treatment.

At one time Burma Forest Officers were just as unanimously in favour of fire-protection. For many years fire-protection was supposed to possess all the virtues of a patent medicine, and the Local Government was urged to extend this work so far as funds and administrative conditions allowed. To err is human, but I wish to point out that we cannot afford to continue to commit errors of judgment. If after pinning our faith to fire-protection as the best means of improving the capital value of our forests, we now devote all our available energies to converting our forests from the Selection to the Uniform System, and if in course of time it is found that

we have committed a second error of judgment, the Department will cease to command any respect or confidence. Before we commit ourselves any further, therefore, I would urge every one to consider the whole question very carefully.

Our principal duty is not so much the collection of revenue, but rather the conservation and improvement of the growing stock in order to increase the capital value of our forests and to render them more and more productive. The first point to be considered, therefore, is to what extent the proposed conversion of our forests will enable us to attain this object. The answer is, I think, that although extraction may be greatly simplified, and although our forests may be made considerably more productive when conversion has been completed, that is, at the end of a rotation of 150 years, yet in the meantime the yield will be reduced considerably. It is proposed to convert on an average $\frac{1}{150}$th part of a working circle each year. Thus, after 75 years, half the area will consist of even-aged woods ranging from one to 75 years of age, and with the exception of possibly a few thinnings, will be unproductive, the yield being derived entirely from the remaining natural forest. In fact, the yield will be reduced to half. Just think what this means! Even during the last fifteen years the price of teak has gone up enormously. The market is rapidly expanding, and the demand is greater than the supply. Already there is dissatisfaction that larger supplies cannot be put on to the market, and it is under these circumstances that we propose to take measures which will reduce the yield to half in 75 years, and almost to nothing towards the end of the rotation. When the trade generally, and the Local Government clearly realise that we are deliberately reducing the yield, and that worse is to come, is it not certain that our successors will be confronted with a storm of indignation, and will it not make matters worse if they attempt to justify these measures by pointing out that in a hundred years or so the supply of teak will be overwhelming?

It has been hinted that the adoption of the Uniform System would enable us to save our faces in the matter of fire-protection. It has further been suggested that it would remedy the deplorable

state of affairs as regards improvement fellings. As the suggestion has been made by a Forest Officer who on another occasion accused me of gross misrepresentation, I think it desirable to give the exact words which are, "This change of system is justified from the fact that under the Selection System . . . . . improvement fellings can be carried out only over a small area over which they should be carried out." The term "improvement fellings" is a synonym for "thinnings in uneven-aged mixed forests," and is used in Burma only to mean the removal of comparatively worthless trees and bamboos in order to free valuable species from suppression. The cost, which can be verified from the Administration Report, averages about eight annas an acre, and therefore even when large areas are gone over, this work does not involve a great amount of labour. On the other hand, the Uniform System, as its name implies, means the creation of uniform even-aged woods by means of natural and artificial reproduction, with a view to obtaining, when an area is gone over once in 150 years, the same as, or a greater yield than is obtained from going over our existing uneven-aged natural forests five times at intervals of thirty years. This will involve the complete removal of the existing growth, much of which work will have to be done departmentally. When making a *taungya* plantation, although a family can on an average clear only about three acres in a season, the existing growth is removed free of cost. Nevertheless, experience has proved that the formation and maintenance of even a comparatively small area of plantations is a severe tax on the staff. Similarly in Europe the overwood is, I believe, usually removed by purchasers, yet although the area has only to be re-stocked, the management of even-aged woods entails such intense work that the size of divisions is reduced to some 40 square miles, or at any rate to an area very much smaller than is as yet practicable in Burma. I consider, therefore, that, under the present conditions in Burma, it will be quite impracticable to obtain sufficient funds and labour to form even-aged woods over $\frac{1}{150}$th of the teak forests under working-plans. The point, however, I wish particularly to have explained is, how, admitting that hitherto improvement fellings have not been carried out in accordance with

the prescription of working-plans, this deplorable state of affairs will be remedied by the conversion of our forests, and by the elaborate regeneration fellings and artificial works of reproduction proposed. When fire-protection was first attempted some of the claims put forward appear in the light of subsequent results to have been somewhat far-fetched, but I am inclined to think that our successors will consider some of the reasons with which we bolster up the present scheme, utterly ridiculous.

The principal reason for adopting the Uniform System is that the extraction of the yield will be greatly simplified. I have been severely censured for suggesting that when conversion is complete, there will be great risk of anthrax among the elephants; but I am not yet convinced of my error and a recent experience has confirmed me in my opinion. In the Upper Chindwin Division, of which I am at present in charge, the working-plans officer took special precautions to reduce the risk of anthrax, and on that account distributed the girdlings over several felling-series. Nevertheless anthrax has broken out, and the lessees attribute this entirely to the large number of trees girdled in some of the compartments. As under the Uniform System the fellings will pass over an area every 150 years instead of every 30 years, and as it is intended to obtain a very much greater yield than at present, it seems to me that a yield of at least 500 trees per 100 acres will be general, whereas a yield of 50 to 100 acres is now the exception. Instead of scolding me for pointing out possible difficulties, it would, I think, be more to the point if an estimate were given of the average size of the compartments and probable number of trees which will be obtained under the Uniform System. It would then be possible to form a sounder judgment as to the possible risk of anthrax.

As was somewhat the case in the question of fire-protection, those who advocate the adoption of the Uniform System appear to be of the opinion that to be dogmatic obviates the need of carefully-considered arguments. As an instance, I would refer to an article in the September number of the *Indian Forester* for 1914, called "Teak in Burma," by O. P., in which the author,

without attempting to give any reasons, makes the sweeping assertion that the Selection System is unsuited to teak. I can only account for this opinion by the assumption that what was really in the writer's mind, was the fact that in Europe, when considerable light is let on to the ground, the first species to appear are light-demanders, which spring up in great profusion, and which, therefore, can readily be formed into even-aged woods. In Burma, however, when considerable light is let on to the ground, as, for instance, when a *taungya* is made, a dense growth of grass, creepers and soft-wooded species spring up. These are the true light-demanders, and if we were interested in growing crops of Kaing grass, we might have some reason for asserting that the Selection System was unsuitable. But when we turn to tree growth and bamboos, we find that it is the bamboos which adopt the peculiarities of light-demanders in Europe, and which spring up gregariously, whereas the more light-demanding species such as teak spring up sporadically, one here and one there. Teak, in fact, seldom or never springs up so as to form even-aged woods naturally, and it is only by the extremely artificial method of *taungya* plantations and by constant weedings that even-aged woods can be obtained. Under these circumstances to assert dogmatically, that the Selection System is unsuited to teak seems to me to be pure moonshine.

Mr. Troup, in a similarly dogmatic manner makes the assertion that a "change of system is justified by the fact that under the Selection System the natural reproduction of teak is not so plentiful as it should be even in areas where improvement fellings have been carried out. It is often absent and under the present method of treatment the teak will disappear over large areas." After all, teak has for centuries and centuries had to put up with the type of forest which we find now, and judging by the growing stock it appears to have held its own successfully in the struggle for existence with innumerable other species. It comes as a shock, therefore, when we find it stated authoritatively by an officer for whose opinion most of us have a great respect, that teak is suddenly in danger of extermination. However, if we look up actual

statistics in which the factor of imagination is eliminated, we find that in almost every working circle the supply of seedlings is ample. Moreover, Mr. Troup has, in a bulletin summarising working-plans in Burma, published the fact that for the whole of Burma the average proportion of fifth class to second class trees is as 61 to 5, which cannot be considered inadequate. Under these circumstances it seems, therefore, not unreasonable to demand an explanation as to the grounds on which this amazing assertion is based.

The following sentence which appeared in a printed note submitted to the Local Government seems to me of great significance, in that it indicates the attitude of mind with which we approach this question. The sentence, or rather it is part of a sentence, is "Outside India the Selection System is regarded as quite unsuitable for a light-demanding species." Are we to suppose that "Outside India" includes America, Africa, Asia, Australia, Russia, Italy, Norway, Sweden, and various other continents and countries where uneven-aged woods predominate? No. Bearing in mind the fact that nearly all of us had to undergo our practical course of training in Germany, what I think is unconsciously meant, is that because the Germans show a decided preference for uneven-aged woods, therefore we ought to follow suit. The Germans have a natural aptitude for forestry, and it is, I think, only natural that we should feel a great admiration for their work. But it seems to me that we go further than this, and allow ourselves blindly to accept their conclusions, and abjectly and unintelligently to initiate their results. For instance, in the controversy on fire-protection, one frequently ran up against the argument that no one disputed the desirability of fire-protection outside India. For many years no attempt was made to prove that the damage caused by fire justified the cost of protection, or to investigate the question in the same thorough manner that the Germans had done in their own country; and in my own mind there is little doubt that fire-protection was undertaken principally because the Germans had, under vastly different conditions, proved that fire was harmful. What other explanation can be given of the fact that for many years those

who disputed the necessity for indiscriminate fire-protection were regarded as unorthodox?

It has been proved that a higher yield per acre and timber of better quality is obtainable from even-aged woods, and as in Germany land is of very great value, and the woods entirely artificial, it is reasonable that a strong preference should be shown for even-aged woods. The same reasons apply both to shade-bearers and light-demaders, and if oak and larch are found in even-aged woods, so also are spruce and silver fir. In Burma, however, the conditions are utterly different.

Let me give an instance of how our methods differ from those of the Germans. Almost invariably, when any article or memorandum is written about the Uniform System, copious references are made to the Mohnyin reserve, where the system is being experimentally tested. What are the facts? The Mohnyin reserve is one of the few areas in Burma where the conditions are abnormal. There is, for instance, little undergrowth of bamboo and the middle-age gradations are inadequately represented. Moreover, the area is a small one, about 30 square miles, and it is evident that the measures which are being adopted would be impracticable in a division comprising some 400 square miles of reserved forests. Most of us have spent a period undergoing a practical course of training in Germany, but I do not think any of us can recall an instance of Germans going out of their way to select an abnormal area in order to test the practicability and suitability of a new system.

Let any one, if he can, prove that teak cannot, or never has reproduced itself in a natural uneven-aged forest, and that under our present antiquated system of treatment, teak will disappear over large areas. Let it be proved that teak in even-aged woods has no defects, whereas the teak grown in the uneven-aged forests of Burma is comparatively worthless; but for goodness' sake let this be clearly proved beyond dispute, and do not let us think that we must make uniform even-aged woods merely because the Germans do.

TWISTED FIBRES IN CHIR PINE.

BY F. CANNING, I.F.S.

The further the investigation of the chir pine forests in the Almora District proceeds, the more is the importance of this defect appreciated. This is more particularly the case with regard to those areas which were formerly considered so valuable for commercial exploitation. Mr. Smythies' note * on this subject deals, so far as my experience shows, with the forests of the Naini Tal District and the Western portion of the Almora District. The latter district has now been divided into an Eastern and Western Division, and while I have generally no criticism to offer on the remarks as applying to the latter, they do not apply to the former. To deal with the subject in the order taken by Mr. Smythies in his note, the following may be noted as regards the East of the Almora District :—

(*a*) *Characteristics and occurrence of trees with twisted fibre.*—It will simplify matters if the twist from right to left upwards is called a left-handed twist and that from left to right a right-handed twist. In Eastern Almora the right-handed twist is the more prevalent. It is most noticeable in the old trees : such trees will generally have fine height growth and well-formed boles similar to those described in Mr. Smythies' note. Generally, the trees in Eastern Almora are of much greater height and girth than in Western Almora. The population in the West is denser than in the East and the demand for timber greater. This is certainly one of the main reasons why large trees are more common in the East than in the West. The twist in these large trees is generally slight near the base and gradually becomes worse and worse higher up the stem. The maximum angle of twist noticed is 45° with the vertical and this was found high up in the stem.

Practically the only way to tell the right-hand twisted tree from any considerable distance is by the contorted form of the branches. All degrees of these contortions are found, but they are generally not so fantastic as in the case of the left-hand twisted

* Published in the March issue of the *Indian Forester*.

trees. All these contorted branches have very twisted fibres. At a short distance from one of these large trees with twisted fibre the direction of the twist can be told by the appearance of the bark. The smaller exfoliations of the bark flake off with their longer sides more or less parallel to the direction of the fibres of the wood underneath and leave a faint but distinguishable marking on the bark. The marking on the bark cannot, however, always be seen. On trees still putting on good girth growth the bark is thick, dark-coloured, more deeply fissured and exfoliates more rapidly, and the markings are not discernable. Consequently twist cannot be told in this manner in any young tree and only in fact in trees practically mature and over-mature. The markings on the bark further may often not indicate the full degree of twist, and it may be found that the wood underneath is more twisted than would appear from the markings on the bark. In these cases it would appear that the degree of twist in the fibres of such trees is gradually changing, and that the markings on the bark indicate the degree at the time when those tissues were formed. This, in the case of mature trees with very slowly exfoliating bark, may represent a considerable interval of time (such trees have been noticed with 40, 50, 60 annual rings in the last three inches of diameter growth of the wood). These remarks regarding the marking of the bark apply equally well to left-hand twisted trees. In mature and over-mature specimens of the latter a very marked spiral arrangement of the plates of the bark indicates a badly twisted tree. The remarkable bulbous base of the left-hand twisted tree is not found in right-hand twisted trees.

Use of timber from right-hand twisted trees.—It is a generally accepted fact in the district that a right-hand twisted tree is not so bad as a left-hand twisted tree. So long as the commercial exploitation of tracts containing these trees had not commenced, the right-holder was the only person affected. His usual custom was to fell a tree and use only a small portion from the base of the same, leaving the remainder to rot in the forest. As the twist is least towards the base it did not affect him much. With commercial exploitation this twist is really more objectionable than the

left-hand one, as sawyers fell a tree which on casual examination at the base appears fairly straight and then having had the trouble of felling it are loth to leave the portion in which the twist is bad. Forest Officers in marking such trees are apt to make bad mistakes in classifying them as fit for sawing, unless great care is taken, and even with great care, must often be in doubt. Until the tree is actually felled and barked, the exact degree of twist in the upper portions cannot be definitely known, and consequently until then the possibility of its being fit for sawing is doubtful. Whether right-hand twisted sawn timber warps in the same manner as that of the left-hand twisted trees is not yet determined. It appears likely that it is not so bad, but the doubt at present precludes its use for Railway sleepers. In checking sleepers sawn from such trees when freshly sawn, I have often only been able to see the twist in one or two sleepers out of a batch of 16 sawn from the same tree. If any sleeper has a wane the twist of the fibre is clear on it, but with four sawn surfaces it is very difficult to detect. The twist is not so great that the timber could not be split up into billets for fuel, but in the tracts where it is found there is no demand for fuel of this nature.

The right-hand twist has not so far been noticed in the younger trees to any great extent, but this cannot be taken at all to mean that it does not exist. The observations on this point are at present quite inadequate. Further, twist of all kind is much more difficult to observe in young trees, and it appears that right-handed twist develops with age as is shown by its greater intensity in the higher portions of the stem of the old trees.

The remark in Mr. Smythies' note on trees outgrowing twist may be here mentioned. Practically all the fifth class trees in Almora that the writer has tested by cutting off the bark have left-handed twist more or less up to about 6 feet and the only outward sign of this is that there is a curve in the stem up to a height of 4 or 5 feet. This almost universal distribution of twist, or at least the tendency to twist in the young trees in the Almora forests, is one of the most serious problems which will have to be dealt with in their future management. This curve at the base of the tree

can be traced from the sapling and almost from the seedling stage and appears to be due to injury or unfavourable locality. As the tree advances in size the slight curve naturally becomes less conspicuous, but the writer would not like at present to support the view that the tree grows out of twist; the stem certainly is straighter and the degree of twist may appear less. This is, however, during the period of rapid height growth, and the writer anticipates that it will be found that the twist persists and becomes more marked as the rate of height growth becomes less. This theory may possibly explain why large right-hand twisted trees have the twist much more intense in the higher portions of the stem. The writer has not observed the inner core of twisted fibres with an external layer of straight fibres. It would be interesting to know if this is a feature of the Naini Tal Division as it might possibly be the result of ameliorated circumstances resulting from efficient protection.

Distribution.—Right-hand twist is the feature of the Eastern Almora Division. The forests of this Division have as yet been only partially examined, but so far this twist has been found everywhere. It was found very prevalent in felling coupes in both the Gori and Ramganga valleys, where left-hand twist was almost entirely absent. In the middle of the district it appears to mix gradually with left-hand twist and becomes rare in the Western Almora Division where, as Mr. Smythies notes, left-hand twist is almost universally the rule. Its relation to geological formations have not yet been observed. Aspect has apparently little effect on its distribution, and proximity to villages only in so far as in these neighbourhoods the straight-grained trees have gradually been removed by the villagers. Right-hand twist does not seem to be affected so much by unfavourable locality as it occurs in forests of very fine well-grown trees.

Fire.—As regards the remarks in the Kumaon Circle report, the writer has since found that in an area protected from fire for three years innumerable seedlings which have sprung up have almost all developed swollen carroty bases with twisted cores of wood. The old trees here are often twisted both right and left-handed.

Heredity.—In one area where the mother trees had almost all right-hand twisted fibre and the conditions were unfavourable to the seedlings, the carroty bases were formed, but twist of the fibres was left-handed.

Causes.—The writer agrees with the general remarks of Mr. Smythies regarding the cause of the left-hand twist, but is doubtful whether they will apply to right-hand twist. Also, as regards the necessary measures to be taken, the writer agrees but considers that the problem of eliminating twisted fibre specimens in a sapling forest will be far from easy, as they are at this stage so difficult to detect. In Almora also the extent of twist is so great, that complete success in one generation can hardly be anticipated. The phenomenon is worthy of very careful investigation and experimental treatment of areas to be kept under observation.

FURTHER NOTES FROM OLD MADRAS FOREST REPORTS.

BY C. E. C. FISCHER, I.F.S.

It happened that I had been delving for some months past into old records when the October issue of the *Indian Forester* with its happily inspired "Notes from Old Madras Forest Records" reached me. As the records that I have gone through date back to 1842, I trust that I may be allowed to pay that tribute which is the sincerest flattery.

Prior to 1844 teak timber was obtained for the Bombay Dockyard for the purposes of the Indian Navy through contractors from the forests of Canara, Malabar, Cochin and Travancore. After that date, for some years, teak was extracted by Government agency, but without establishing a special Department.

In 1846 Collectors were called upon to submit proposals for working valuable forests in their respective districts. The Collector of Coimbatore suggested that the Government forest should be worked through contractors, "the sooner the better," as apparently the special staff engaged was unsatisfactory and insufficiently supervised. He reported that "The teak forests in this district are immense and will admit of the supply of

timber to any extent, of good and unexceptional quality. Similar forests are not to be met with either in the Bengal or Bombay Presidencies"

The estimate of inexhaustibility was soon to be refuted here as elsewhere, as will appear later.

In 1848 the Government of Bombay proposed, somewhat naively, that certain forests in the Madras Presidency (in the Canara and Malabar districts) be placed under the administration of Dr. Alexander Gibson, who had been appointed Conservator of Forests in the Bombay Presidency in 1846. Very naturally the Government of Madras objected, not only on account of the difficulty of controlling areas so remote, but because it considered that "the conservancy of forests should remain in the hands of the Government which exercises Judicial, Executive and Police authority." This objection was upheld by the Government of India (Order No. 1016, Home Department, dated Fort William, 18th November 1848). Nevertheless, the northern portion of Canara was transferred to Bombay in 1862 or 1863.

At this time, possibly as a result of these negotiations, Captain J. Michael, of the Madras Army, was appointed for eight months to investigate the Anamalai teak forests of the Coimbatore District. This gentleman may be considered as the first Madras Forest Officer as, eventually, he became a member of the Forest Service created nine years later.

At first Captain Michael was under the orders of the Civil Engineer of the Coimbatore District, at that time Major (later Major-General) F. C. Cotton, R. E., a very level-headed officer, who became prominent in later years in the Madras Presidency. Major Cotton accompanied Captain Michael on some of his tours in the forests and his reports are marked by sound judgment and common sense, based on accurate observation. He falls, nevertheless, into the very general error of over-estimating the capacity of forests to yield timber indefinitely and in enormous quantities, without any real attempt at conservancy and perpetuation. He proposed to send annually to the coast, "if necessary, 1,000 teak trees containing at least 400,000 cubic feet of timber."

Major Cotton, however, had not entirely overlooked the necessity of providing for the future and proposed plantations on the lines of Conolly's now famous ones at Nilambur, then but a few years old. One paragraph of this report is worth quoting here:

"I see nothing to lead me to think that it would be advisable to plant teak where teak has grown before. I would rather follow nature and take fresh ground for the new crop. In the American forests, and I believe elsewhere, if the original growth is cut down or destroyed, another description of tree occupies its place and I do not see in any of these jungles young teak rising where the old teak is dying out."

It is interesting to note that a few years later Colonel Beddome (of whom more anon) supported the "toxic theory" as accounting for the failure of teak to reproduce itself under its own shade.

In order to show how soon these same forests deteriorated, I may anticipate and quote from a report of the last-named officer dated March 1866:

"I have travelled almost every portion of the teak forest. . . . the fires have swept through the forest and there is no grass or underwood and I have been able to see every tree. I have no hesitation in saying that the forest requires *complete* rest for 15 or 20 years. With the exception of a few knotted and twisted trees, there is not a teak of any size left, and very few trees that would yield one log. It must be remembered that the few square miles alluded to have been worked incessantly for 16 years, also all the Vengay and Blackwood * too has been taken out during the last three years."

The wastage of timber at that period was appalling. The Bombay Dockyard required "planks" of from 3 to 7 inches thick, 9 to 12 inches wide and 15 to 30 feet long. Sawyers could not be persuaded to work in those malarial forests so that the planks had to be hewn out with the axe. Major Cotton and Captain Michael estimated that 300 to 400 per cent. of the wood was wasted in the process!

* *Pterocarpus Marsupium* and *Dalbergia latifolia.*

In 1853 the control of Forest Conservancy passed from the Civil Engineer to the Collector.

Dr. Gibson appears to have visited some of the Madras forests as evidenced by the following interesting extract from his report *in 1849*:—

" . . . . The plantations formed by the Collector of Malabar * should be carefully attended to. If so, there can be no doubt of their increasing by spontaneous vegetation of seeds . . . . Further, *we should keep in view a fact* I have now fully proved, *viz.*, that teak will grow from cuttings though I should in all cases prefer its extension by seeds."

Captain Michael had an assistant, under the title of "Carpenter," to supervise the fellings and conversions. The first incumbent was a corporal of the Sappers and Miners, and the following quaint communication concerning him is filed among the conservancy records :

"Sir, ...

I have the honour to inform you that 1st corporal P. Q. . . . . of the Sappers and Miners has my consent to his union with Miss W. . . . . X. . . . as it appears from the enclosed certificate that she has received a suitable education for the wife of a Christian soldier.

Prome, Y. . . . Z. . . .,

23rd November *1853*. *Comg. Hd. Qd., Sappers & Miners."*

The girdling of teak prior to felling appears not to have been resorted to before 1848. Captain Michael claimed to have introduced the practice in that year at the suggestion of Major Cotton, the first girdled trees being felled in 1850. Girdling was stopped in 1854 and it is worth while quoting Captain Michael's own words in explanation :

" . . . . it was at the urgent request of the axemen that it was abandoned. Their argument was that the fall of a dead tree with dry brittle branches increased the heart-shake very much more than of a living tree full of sap and elasticity, both as to its trunk and branches. I became fully convinced of the

* Conolly's Nilambur Plantations.

justice of their opinion after observing that they turned out a greater number of sound planks out of a green tree than they did out of a girdled one. I have therefore come to the conclusion that it will be better in future to cut planks from green trees and allow them to season gradually in the forest and while in course of transport to the coast. . . . . "

As far as is known teak was never again girdled and this though the timber was floated for a distance of 70 miles on its way to the coast up to about 1870, when mail transport superseded water carriage.

One is rather startled to find an indent in 1856 from the Bombay Dockyard for two logs of 40′ × 3½′ × 3½′ or 490 cubic feet! Under present conditions it would only be possible to bring out such a log at enormous expense, needless to say that in 1856 the indent was not complied with. One wonders what these monstrous pillars were required for. Dockgates?

The only echo of the Crimean War met with in these records was a request that Captain Michael should ascertain and submit "a certain kind of fly used in blistering" which were then unobtainable in Bombay "owing to the close of the Astracan market." Apparently specimens were sent but either they failed to blister or did so in unapproved fashion, for no more were asked for.

It is rather more curious to observe that the events that so profoundly disturbed the whole of Northern India in 1857, and that exercised so powerful an influence on the future of the Peninsula seem to have left no mark on forest affairs in Coimbatore. As far as these records go the Great Mutiny might never have taken place but for an order of the Accountant-General in November 1858, which directed that in future bills should be headed. "Her Majesty's Government of India, Dr." instead of "The Honourable Company, Dr."

Up to 1857 the officer in charge of the Anamalai forests was known as "Superintendent of the Anamullay Forest," and was subordinated to the Collector. Early in that year Dr. H. Cleghorn (termed by Lord Lawrence "the founder of systematic forestry in India") was appointed the first Conservator of Forests

in the Southern Presidency and a Forest Department was born Captain Michael who was then still the "Superintendent" (with intervals of leave) became "Assistant Conservator" and the control of the forests passed out of the hands of the Collector. This arrangement continued until 1872 when the Conservator became "Inspector of Forests" and little more than an adviser in forest matters, the control passing again to the Collectors, who, in those districts where forests were under their management, were entitled "Collector and Conservator of Forests." This lasted until 1876 when the original arrangement was reverted to till in 1883, Dr. (later Sir) D. Brandis' recommendations were adopted.

Dr. Cleghorn issued his first circular "General instructions to Assistants in the Forest Department" on 27th February 1887. It is evident that he had not then inspected the forests or had an opportunity of realising the nature of the work, for admirable as the instructions are they were clearly impracticable in so m instances, as the following extracts will show :—

" . . . .

2. To obtain a complete knowledge of the quantity and quality of timber in each forest of the district, and to prepare a forest chart according to a fixed scale, indicating as far as possible the number and size of the more valuable forest trees within their respective ranges.

3. To prevent any kind of depredation or damage being committed in the forests . . . . . and to prevent private individuals cutting or damaging trees of any description . . .

4. To improve the forests by clearing, planting and by unremitting attention to young trees . . . .

. . . .

6. To supply tabular statements . . . .

. . . .

8. To transmit to the office of the Department . . . . . . any new or remarkable production of the forests.

. . . .

For many years the Assistant and Deputy Conservators were military officers. It was so at least in Coimbatore until the middle

of 1870 when Mr. C. G. Douglas took charge. All this officer's successors were trained Foresters.

Captain Michael devoted some time to exploration and was the first European to scale the highest peaks of the Anamalai Hills in the district (8,249 feet) and a beautiful grassy valley at 6,500 feet bears his name to this day. He was compelled to take leave owing to ill-health on three occasions, on one of which he made a voyage to Australia and New Zealand, whence he brought seeds of trees and flowering plants which he presented to the Government Gardens at Ootacamund. At last in 1865 he contracted congestion of the lungs and under advice resigned his post in the Department.

Among the eight military officers who held charge of the Anamalai Forests, for longer or shorter periods, during the two decades from 1850 to 1870, the best known were D. Hamilton and Beddome.

The first is better known as a traveller than a Forest Officer, and was specially deputed to explore the hills of Southern India in search of suitable sites for sanatoria. His name is preserved in "Hamilton's Plateau" in the Travancore Anamalais, as also in the Palnis. He was something of an artist and reproductions from his sketches are to be found in many old records (see also Cleghorn's "Forests and Gardens of Southern India").

Beddome first joined the Forest Department when he was posted as Assistant Conservator in charge of the Anamalais to succeed Hamilton in December 1857. He soon made his mark as we find him already officiating as Conservator in 1860, while still a Lieutenant, with officers of senior military rank under his orders. He made a name in all branches of Natural History, but more especially in Botany. Colonel Beddome retired from the Forest Department in 1881 and lived to enjoy his pension in England for 31 years, retaining an active interest in science to the last.

Practically all the officers employed in the Anamalais up to 1870 were compelled to take sick leave. The two exceptions were Captain Hamilton, who was in charge for short periods only, and Captain Beddome, who appears to have been gifted with an extraordinarily robust constitution.

It 1883 a second Conservatorship was formed, Mr. J. S. Gamble being the first Conservator of the Northern Circle. A curious feature of the partition of the Presidency between the two Circles was that the Nilgiri District was included in the Northern Circle though separated by several hundred miles from any other district of that Circle and surrounded by districts of the Southern Circle. Presumably this arrangement was made with a view to giving the Conservator one hill station—the Southern Circle retaining at least two others.

In 1882-3 Dr. Brandis, Inspector-General of Forests, visited the Madras Presidency and among other changes advocated by him the 'Jungle Conservancy' was amalgamated with the Forest Department and all forest lands brought under one system of control.

A third Conservatorship was formed in 1891 and a fourth in 1911, the number of divisional charges having increased enormously in the intervals.

The Department now confidently awaits the creation of a post of Chief Conservator in the near future.

A FURTHER NOTE ON THE OIL-VALUE OF SOME SANDALWOODS FROM MADRAS.

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO FOREST RESEARCH INSTITUTE, DEHRA DUN.

In Forest Bulletin No. 6, 1911, fifteen samples of Sandalwood from Madras were examined for their oil-value, and the general conclusion arrived at therein was that the Sandalwoods from trees growing in poor rocky soils give more oil than those growing in comparatively good and fertile soils. But the samples examined for the purpose were rather too few, and it was recommended that a larger number of samples should be examined to determine the factors which influence the percentage of oil in Sandalwood. The Chemical Adviser, who was unable to go on tour in order to collect for himself, is greatly indebted to Mr. P. M. Lushington, Conservator of Forests, Central Circle, Madras, for supplying him with forty-four samples of roots and stems of Sandalwoods collected and labelled very carefully from different localities. Their oil-value is given in Table No. I.

TABLE No. I.

Table ot Analysis of Samples of Sandal woods from Madras.

Serial No.	No. and date of letter.	Description of the sample.	Locality and Elevation.	Age of the tree.	Girth.	Soil.	Moisture %.	Oil %.	Remarks.
1	894 of 1912 from Conservator, C. Circle, Madras.	The stem of a tree grown in a garden cut 2 years ago before despatch.	Vizagapatam—Sea-level.	...	...	...	8·21	5·43	
2	C. 1340 of 1912, 15th January 1913.	P2—Roots of a tree cut in Penukonda, Anantapur District.	Madras C. Circle, Anantapur District, 3,050′.	A young tree	At 4′=16″ ...	Rich, dull brown loam with layers of gneiss boulders.	9·00	5·24	
3	Do. ...	P1—Stem ...	Do. ...	Do. ...	Do. ...	Do. ...	9·88	4·72	
4	Do. ...	U1—The root of a tree cut in Upparapalle plantation.	East Cuddapah District. Elevation 709′.	About 30 years	At 4′=18¾″.	Growing near a ravine.	10·15	6·52 by steam. 6·36 by alcohol.	
5	Do. ...	U1—A stem ...	Do. ...	Do. ...	Do. ..	Do. ...	10·02	6·21 by steam. 6.28 by alcohol.	
6	Do. ...	U2—The root ...	Do. ...	25 years old...	At 4′=17″ ...	In gravel soil, not near a ravine.	0·51	4·36 by steam. 4·75 by alcohol.	

7	Do. ...	U2—A stem ...	Do. ...	Do. ...	Do. ...	Do. ...	9·96	4·84
8	Do. ...	M3—The root of a tree cut in Mogalipenta District.	East Cuddapah 2,360′.	About 13 years	Branched girth At $4' = \frac{13\frac{1}{4}''}{10\frac{3}{4}''}$	Sandy loam full of boulders.	10·40	3·44 by steam. 3·84 by alcohol.
9	Do. ...	M3—A1 stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·38	3·21
10	Do. ...	M1—Root of a tree cut in Madanpalle, Chittoor District.	Chittoor District, 2,500′.	15 years ...	At 4′ = 15″ ...	Deep black cotton.	9·95	·51 by steam. 5·47 by alcohol.
11	Do. ...	M1—Stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·30	5·37
12	Do. ...	M2—Root ...	Do. ...	About 20 years.	At 4′ = 19″ ...	Do. ...	11·36	6·21 by steam. 6·68 by alcohol.
		M½—Stem, lower stem attached to root.	Do. ...	Do. ...	Do. ...	Do. ...	11·40	4·95
13	Do. ...	M2a—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·31	5·49
14	Do. ...	H1—Root of a tree cut in Horsleykonda.	Chittoor District, 4,200′.	30 years ...	At ground-level, 33″ branched At $4\frac{1}{2}' = \frac{17''}{14\frac{1}{2}''} \frac{}{16''} \frac{}{11''}$	Sandy loam mixed with gravel.	10·50	3·11 by steam. 3·10 by alcohol.
5	Do. ...	H1—Lower stem attached to root.	Do. ...	Do. ...	Do. ...	Do. ...	10·65	3·10
16	Do. ...	H1A—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·36	3·18

TABLE NO. I—(*continued*).

Table of Analysis of Samples of Sandalwoods from Madras.

Serial No.	No. and date of letter.	Description of the sample.	Locality and Elevation.	Age of the tree.	Girth.	Soil.	Moisture %.	Oil %.	REMARKS.
17	C. 1340 of 1912 15th January 1913.	H_2—Root ...	Chittoor District, 4,200'.	A young tree about 15 years old.	At base = 15½". (At 4' = 12")	Sandy loam mixed with gravel.	11·23	5·24 by steam. 5·00 by alcohol.	
18	Do. ...	H½—Lower stem attached to root.	Do. ...	Do. ..	Do. ...	Do. ...	10·79	4·87	
19	Do. ...	H2—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	13·30	5·68	
20	1340 of 1912, 24th January 1913.	R i—Root ...	Ramandrug, Bellary Dist., 3,200'.	About 39 years	At 4½' = 31".	Sandy loam with boulders.	11·17	5·60 by steam. 5·56 by ether. 5·78 by alcohol.	
21	Do. ...	R i—Lower stem attached to root.	Do. ...	Do. ...	Do. ...	Do. ...	12·20	3·28 by steam. 3·57 by alcohol.	
22	Do. ...	Ri—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	12·03	3·22 by steam. 3·22 by alcohol.	
23	Do. ...	Rii—Root ...	3,200'	About 25 years	At 4' = 20" ...	Do. ...	11·21	4·50 by steam. 4·58 by ether. 5·20 by alcohol.	
24	Do. ...	Rii - Lower stem ...	Do. ...	Do. ...	Do ..	Do. ...	10·58	3·83	

25	Do. ...	Rii—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·80	3·83
26	Do. ...	Riii—Root ...	1,920′	About 35 years	At 4′=27½″...	Sandy loam ...	10·91	3·34 by steam. 2·78 by ether. 2·86 by alcohol.
27	Do. ...	Riii—Lower stem ...	Do. ...	Do. ...	Do. ...	Do. ...	11·66	2·48
28	Do. ...	Riii—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	12·08	2·56
29	Do. ...	Riv—Root ...	1,920′	About 34 years	At 4′=27″ ...	Red loam ...	8·61	5·09 by steam. 5·51 } by 5·56 } alcohol.
30	Do. ...	Riv—Lower stem ...	Do. ...	Do. ...	Do. ...	Do. ...	8·43	5·24
31	Do. ...	Riv—Upper stem ...	Do ...	Do. ...	Do. ...	Do. ...	11·61	4·91
32	Do. ...	Rv—Root ...	625′	About 34 years	At 4′=26¾″...	Sandy loam with boulders	8·95	2·68 by steam. 2·74 by alcohol.
33	Do. ...	Rv—Lower stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·66	2·77
34	Do. ...	Rv—Upper stem ...	Do. ...	Do. ...	Do. ...	Do. ...	10·44	2·88
35	Do. ...	Rvi—Root ...	625′	About 20 years	At 4′=16″ ...	Do. ...	8·14	6·91 by steam. 5·72 by alcohol.
36	Do. ...	Rvi—Stem ..	Do. ...	Do ...	Do. ..	Do. ...	13·15	6·13 by steam. 5·95 by alcohol.

It will be seen that neither elevation nor age nor locality has any definite relation with the quality of the Sandalwood as regards the percentage of essential oil in it. In the Table No. II, some of the samples have been re-arranged to make it clear that the only factor which appears to affect the percentage *of oil is the soil.*

The conclusion arrived at in Forest Bulletin No. 6 of 1911 is confirmed by these results, the trees growing in comparatively good, fertile soil yield heart-wood poorer in essential oil than those growing in poor, rocky, gravelly soils.

TABLE No. II.

Serial No.	No. of the previous table.	Elevation.	Girth.	Age.	Oil %.	Soil.	REMARKS.
1	35 Rvi—Root	625′	16″	20 years ...	6·91	Sandy loam with boulders.	...
2	32 Rv—Root	625′	20¾″	34 years ...	2·68	Same as above ...	Inexplicably low.
3	6 U2—Root	700′	17″	25 years ...	4·36	Not growing near a ravine.	Soil better than No. 4.
4	4 U1—Root	700′	18¾″	30 years ...	6·52	Growing near a ravine	Rocky soil.
5	26 Riii—Root	1,920′	27″	35 years ...	3·34	Red loam ...	Soil naturally more fertile than No. 6.
6	29 Riv—Root	1,920′	27½″	35 years ...	5·51	Sandy loam ...	...
7	37 Ve—Root	2,300′	26″	...	3·86	Deep red loam ...	Soil naturally more fertile than No. 8.
8	39 Na—Root	2,200′	24″	Older tree ...	6·20	Gravelly loam ...	Percentage nearly the same, the age seems to have no effect.
9	41 Na2—Root	2,200′	18″	Younger tree ...	5·60	Do. ...	
10	43 Ne—Root	2,200′	18″	...	5·69	With loose quartzite gravelly loam.	...
11	10 M1—Root	2,500′	15″	15 years ...	5·51	Deep black cotton ...	Age has no effect, percentage nearly the same.
12	12 M2—Root	2,500′	19″	20 years ...	0·21	Do. ...	
13	20 R1—Root	3,200′	31″	34 years ...	5·60	Sandy loam with boulders.	The older tree is richer.
14	23 R2—Root	3,20	20″	25 years ...	4·58	Do. ...	
15	14 H1—Root	4,200′	33″	30 years ...	3·11	Sandy loam mixed with gravel.	In this case the younger tree is richer.
16	17 H2—Root	4,200′	15¼″	15 years ...	5·24	Do. ...	

In conclusion, it may be pointed out that the percentage of oil in Sandalwoods from Madras varies from 3 to 6 per cent., and that the roots seem to yield slightly more oil than the stems. Taking the experimental error to be 0·5 per cent., it may, however, be said that, practically speaking, the heart-wood, whether of the root or of the stem, yields nearly the same percentage of oil.

EXTRACTS.

Dr. JOHN NISBET.

In last month's *Forester* we inserted an obituary notice of Dr. John Nisbet. We have extracted the following from the *Transactions of the Royal Scottish Arboricultural Society*, which shows the esteem in which Dr. Nisbet was held in Scotland:—

"By the death of Dr. John Nisbet, Forestry Adviser to the Board of Agriculture in Scotland, which took place on the 30th November last, at St. Mary's Lodge, Exmouth, the Society has lost a valued and honoured member. Dr. Nisbet was a pioneer, and one of the ablest exponents, of scientific forestry in the United Kingdom. To him more than to any one is due the progress, little though it be, we have made towards a rational appreciation of our responsibilities in the way of growing timber for profit.

Born in 1853, John Nisbet was educated at the Edinburgh Institution and University. Thence he passed into the Indian Forestry Service in 1875. Studying at Munich during his training, he took the degree of Doctor in National Economy, and, as the favourite pupil of Gayer, acquired a profound knowledge of the science of forestry, which he carried with him into his Indian

service, from which he retired in 1900, after reaching the rank of Conservator. Routine work, however telling, in official service is known to but few, and Nisbet's contribution to the development of Indian forestry is merged in the merit of the Department. In recognition of this he was decorated with the Kaiser-i-Hind gold medal for public services in India at the Delhi Durbar, 1903.

We in this country might have heard little, if anything, of him had he not foreseen that the growing timber consumption of the world, the reckless destruction of timber in virgin areas, and the inadequate response of this country in the way of future supply, were factors of a timber famine which must come upon Great Britain unless timely steps were taken to improve its forestry. Early in the nineties of last century, whilst still in the Indian Service, Nisbet, gifted with a ready and instructive pen, began to approach the public by lectures, by articles in magazines, and by text-books of forestry, in his endeavour to stir up interest in the problem of timber supply and scientific forestry. Among his more important publications are *British Forest Trees* (1893), *Protection of Woodlands* (1893), *Essays on Sylvicultural Subjects* (1893), *Studies in Forestry* (1894), *Burma under British Rule* (1901), articles on forestry in the *Victoria History of the Counties of England* (1903—1907), *The Forester: a Practical Treatise on British Forestry and Arboriculture* (1905), *Our Forests and Woodlands*, second edition (1908), and *The Elements of British Forestry* (1911). His was, however, a "cry in the wilderness." Forl ong he met with little support. Nowadays, when the appreciation of timber is making itself felt, when the politician has found in forestry an aid to his cry of "back to the land," and when development schemes and the foundation of professorships and lectureships and Schools of Forestry are attracting attention, we realise that the importance of the timber question is being recognised. To Dr. Nisbet we owe the awakening. There was a time, on the retirement of Dr. Somerville from the Lectureship on Forestry in the University of Edinburgh, when, had Dr. Nisbet been within hail, he might have been successor. Later, after his retirement from India, he became Professor of Forestry in the West of Scotland Agricultural College,

retiring in 1912, when he joined the Board of Agriculture for Scotland as its Chief Forestry Adviser. To this Board his death brings a heavy loss. Dr. Nisbet's long and active interest in and association with forestry gave him a broad outlook on all matters pertaining to the subject, and all the more important Government commissions and committees on forestry which have sat within recent years have benefited by his wise and judicious counsel.

Dr. Nisbet was for long closely associated with the work of the Royal Scottish Arboricultural Society and acted for several years as Hon. Editor of its *Transactions*. He also contributed many original articles of great value to the pages of that Journal. On the occasion of the Diamond Jubilee celebrations of the Society, Dr. Nisbet was singled out, along with Sir Ronald Munro Ferguson and a number of distinguished British and foreign foresters, to receive the Honorary Membership of the Society, which is the highest honour it has to bestow. On that occasion the President (Captain Stirling) said, in reference to him:—'The last name, but by no means the least on the list, is that of Dr. John Nisbet, Forestry Adviser to the Board of Agriculture for Scotland, who, I think, by the very able books he has written on the subject, was the first to arouse any very wide-spread interest in scientific sylviculture in Scotland.' "

PLANT-ROOT TOXIN.

The effects of growing grass over the roots of fruit and other trees have been studied for a score of years at the Woburn Experimental Farm in England. From the results it is concluded that every growing crop causes the formation in the soil of a substance that is poisonous to other plants, and more so to itself. This toxin gradually oxidises, loses its toxicity, and increases the soil's fertility. Plants that have been poisoned are stimulated by the oxidised soil, and outgrow those that have not come under the influence of the toxin, except in cases where the toxic effect has been so great as to produce permanent stunting. The toxic effect varies with the soil, the plant affected, and the vigour of the toxin-yielding plant. It appears that the toxin is not excreted, but is formed from the débris of the roots.—[*Capital.*]

VITALITY OF PLANTS.

Plants have been found to be much more sensitive to drugs than human beings, and it has been suggested that they have a nervous system, with a heart that is affected by the same chemicals as the human heart, and can be stopped by poison and restored to action by a different agent. By experiments on the *Mimosa*, or sensitive plant, Prof. J. C. Bose lately showed the effects of various stimuli to the Royal Society of Medicine in London. Shock produces contractions like those of a muscle, and certain drugs give rise to a series of twitches which are large if the drug is stimulating, but diminish and cease if the plant is being poisoned. Plant vitality, like animal energy, proves to be at lowest ebb in the early morning hours. The closing of leaves does not indicate that a plant is asleep, but by the responses given to blows at every hour of day and night, it has been found that plants keep awake in the evening, gradually falling asleep after midnight, and awaking about 9 o'clock in the forenoon, becoming fully alive about noon. An interesting observation is that a considerable electric discharge takes place at the instant when a plant dies.—[*Capital.*]

LOOKING FOR BIG TREES.

According to the *Railway Review* announcement was made recently by the American Genetic Association that two prizes of $100 each have been offered for two photographs. One of the largest tree of a nut-bearing variety in the United States, and one of the largest broad-leaf tree which does not bear edible seeds. In the first class, for example, are included trees such as chestnut, oak, walnut, butternut and pecan; and in the second' trees such as elm, birch, maple, cottonwood, and tulip poplar. No photographs of cone-bearing trees are wanted, since it is definitely known that the California big trees have no rivals among conifers. The purpose of the competition, as stated by the Association, is to find out in what regions the native trees attain their largest growth and under what conditions they thrive best. When these large

trees are located and the measurements authenticated, the Association hopes that it may be possible to secure seeds, cuttings, or grafting wood from thrifty trees in the region where they grow, to see whether finer specimens may be propagated in other parts of the country.—[*Indian Engineering.*]

A YEAR'S LUMBER CONSUMPTION.

Statistics have been compiled by the United States Forest Service which show for the first time precisely how the lumber produced in the country is utilised. About 45,000 million feet of lumber of all kinds is the annual production in the United States; of this nearly 25,000 million feet, board measure, are further manufactured, the other portion remaining for rough construction lumber and for similar purposes. This is exclusive of material which reaches its final use in the form of fuel, railroad ties, posts, poles, pulpwood, cooperage, wood distillates, and the barks and extracts demanded by the tanning industry.

Nearly or quite 100 different woods are used in the United States under their own names, while an unknown number find their way to shops and factories without being identified or separately listed except under general names.

In quantity the softwoods, the needle-leaf or coniferous trees are most important, but there is a greater number of species among the hardwoods, or broad-leaf trees. Yellow pine comes first with more than 8,000 million feet, followed by white pine with 3,000 million, and Douglas fir with a little more than 2,000 million. Oak, including all species, has nearly 2,000 million feet, and is the most important hardwood. Maple comes next. Dogwood comes about half way down the list with more than seven million board feet, and of those species mentioned Turkish boxwood comes last, with less than 30 thousand feet, followed by many others too insignificant to list, but making a total of all kinds of more than a million feet. Of the native species, laurel, holly and yucca fall very near the foot of the list in relative quantities used.

Fifty-five principal industries use wood as raw material. More than one-half of the total consumption consist of planing mill products, the largest items of which are flooring, siding, ceiling and finishing. The next industry, in point of quantity of wood used, is the manufacture of boxes and crates. Nearly four times as much wood is demanded by makers of boxes and crates as by the builders of steam and electric cars, which come next, and five-fold the amount that goes into furniture, which in turn leads vehicle manufacture. Vehicles demand surprisingly large supplies of wood, and much of it must be of a high class in order to meet requirements for frames, gears and bodies. Chairs, listed separately from furniture, come after novelties and supplies for dairymen, poultry-keepers and apiarists, and just before handles and musical instruments. About midway down the list come pumps and wood pipes. Among the products important enough to list separately are canes and umbrella sticks, brooms, firearms, artificial limbs and tobacco pipes.—[*Commercial America.*]

THE SHORTAGE OF TANNING MATERIALS.

The following note has been circulated by the Imperial Institute :—

Tanners, and consequently manufacturers of boots and all leather goods, are faced by a serious situation owing to the difficulties caused by the war in obtaining tanning extracts. Last year the value of tanning extracts of all kinds imported into the United Kingdom reached £922,600. Supplies from Italy have now been wholly, and from France partially, stopped owing to the increased demand for military purposes in these countries. Quebracho wood extract, a well-known tanning material, is arriving in fair quantities from South America, but with the higher freight and insurance and the increased demand the price is bound to rise materially. The supply of valonia, one of the most favourite tanning materials, extracted from the acorn cups of the Turkish oak, is cut off by the entry of Turkey into the war field, and a substitute is urgently needed.

Fortunately the British Colonies should be able to fill the gap, both South Africa and, in a lesser degree, the Commonwealth of Australia having for some years done a considerable export trade in wattle-bark, while East Africa is also now in a position to begin sending shipments. The value of wattle-bark for tanning has been sufficiently demonstrated by a series of experiments conducted at the Imperial Institute where samples of the bark from British Colonies and of leathers tanned with it may be inspected. Wattle-bark has been used moreover and highly appreciated for some time in Germany, where, curiously, the bulk of the supply forwarded to Europe from the British Colonies has hitherto been ultimately sent. As a large and constant supply is available at a price which is very cheap as compared with that of valonia (which wattle-bark should be able to replace), it is to be hoped that wattle-bark will now be regularly used by British tanners. A difficulty in the way hitherto has been the absence of factories for preparing the bark extract in the country of origin, but this defect is, in the case of South Africa at all events, apparently about to be removed. It is to be hoped that British tanning extract makers will also give their attention to this side of the question.—[*The Pioneer.*]

EXPORTS OF FOREST PRODUCTS.

The statement below relating to *Exports of Forest Products* is taken from the "Annual Return of Statistics relating to Forest Administration in British India" for 1912-13, recently issued :—

Articles of Forest Produce.	Quantity in tons of 20 cwt. in the case of teak and other timbers, cubic tons.		Valuation at Port of shipment in 1912-13.	
	Average of 5 years, 1907-08 to 1911-12.	In 1912-13	Total.	Per ton.
1	2	3	4	5
			Rs.	Rs.
Caoutchouc, raw	194	731	59,13,893	8,090
Lac — Button	1,813	2,075	21,86,106	1,054
Lac — Shell	17,715	16,809	1,76,81,250	1,054
Lac — Stick, seed and other kinds ...	1,952	2,524	12,65,828	501
Cutch and gambier	3,675	3,438	10,66,483	310
Myrabolans	73,198	69,888	62,14,190	89
Cardamoms	136	119	5,66,471	4,760
Sandal, Ebony and ornamental woods	(*a*)	(*a*)	15,71,194	...
Teak	40,769	61,421	95,24,339	155
Other timbers	5,304	9,066	7,90,859	87
	Total in 1912-13 ...		4,67,80,613	
	" " 1911-12 ...		3,96,36,932	
	" " 1910-11 ...		4,26,71,543	
	" " 1909-10 ...		(*b*) 4,20,96,717	
	" " 1908-09 ...		(*b*) 4,06,20,228	

(*a*) Quantity (whether by weight or measurement) not recorded.
(*b*) Corrected figure. Includes "other timbers" previously excluded.

[*Indian Trade Journal.*]

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INDIAN FORESTER

MAY, 1915.

"FORESTRY AND THE WAR."

In the *Quarterly Journal of Forestry* for January last appears an instructive article, from the pen of Sir William Schlich on the Forest Policy of the British Isles. The author begins by pointing out that it is not unlikely that there may be a serious shortage of pit props and that such shortage may entail the shutting down of a portion of our coal-pits. He then refers to the planting up of lands in Great Britain and to the talk and discussion that the subject has provoked for many years back, to the work of various lecturers, commissions and committees, pointing out that all this has resulted in practically nothing being done until quite recently, and that what has been done, though in the right direction, has signally failed to increase the area of British forests. "Too much talking and too little action." Sir William Schlich indicates that a Systematic Forest Policy would result in the creation of securities much steadier than consols, the price of which in the last 15 years has dropped from 112½ or even more, to 68½. He advocates the increase of the forest area of the country holding this to be the bounden duty of Government,

showing that in order to do this it is not necessary to take a single acre out of cultivation. Nor does he suggest the formation of large blocks of woodland as an essential, thinking that areas with a minimum of 500 acres would be suitable units, each to be placed under the charge of a woodman, who would employ agricultural labourers to do the bulk of the work in the winter months when agriculture is more or less at a standstill.

" Demonstration areas and Schools of Forestry are all very well, but they will not materially increase the timber supply of the country ; nor will the attempts at producing fresh species or new varieties of timber trees, which some people think will be the salvation of the forestry question. Such theories will postpone action for at least a generation. Our species with the Douglas fir are quite good enough to yield heavy crops of timber, if they are treated in the proper way. What we require is immediate action, since we have already lost too much time. The last Forestry Committee assembled by the Board of Agriculture proposed as a beginning the establishment of five circles of 5,000 acres each of new forests in various parts of England and Wales. The establishment of even one such circle is worth more than all the demonstration areas ever suggested for England and Scotland. There are quite enough able foresters to start work at once, and that is what is really wanted.

Action, and again action, is what we need rather than these ever-recurring commissions and committees."

We are in entire agreement with Sir William Schlich. There has been far too much academic discussion, too many futile commissions and too much useless talk about schools, demonstration areas, assistance to private landowners, etc.

Looking back over the last 20 years what do we see ? When Cooper's Hill was abolished there was a great opportunity given for the creation of, a National School of Forestry. This was not taken advantage of, but probationers for the Indian Forest Department were given a course of training at Oxford with the natural result that other centres of education exhibited jealousy that Oxford was so favoured and an agitation was started for establishing

courses of Forestry attached to various Universities, etc., throughout the country. This agitation partly succeeded and we now see various schools of forestry established, each endeavouring to get the better of the others and secure students for whom there is a very limited opening in after-life. We were some little time ago shown a cartoon (not published) which depicted a wretched forest student surrounded by birds of prey representing various educational establishments trying to get hold of him. What we take to be the desideratum is a National School of Forestry, such as exists in France, maintained by Government, at which could be trained men for the Indian and Colonial services and candidates for a Forestry Department in Great Britain. Where this school should be located is a matter of very secondary importance. It might be Oxford, it might be Cambridge or probably better still in the New Forest or in the Forest of Dean—this would be a detail the settlement of which should not present much difficulty. With the establishment of this school should be inaugurated or perfected the systematic treatment of the various woodlands belonging to the Crown and year by year sums should be set aside to purchase new areas with the object of gradually afforesting them. To our mind the question of demonstration areas, of Forest advisers scattered over the country, of Forest advisers sitting in offices in Government Secretariats is futile and beside the mark while such often involve a waste of public money. What we would like to see would be the establishment of a National School of Forestry, the systematic management, under the advice and control of this school, of Crown woodlands and the extension of these latter by the gradual planting up of areas acquired by purchase from year to year. Thus a Forestry Department would be formed, small at first, but increasing in size, as further demands arise, under the control of one man who would be responsible to the Government for it. He should control the National School, and be at the same time in charge of all State Forests and woodlands. His nomenclature would be of little importance, he might be called Inspector-General, Director or any suitable term to define his status might be employed. What is required is one responsible

officer who would be in charge of existing forests, and of areas gradually purchased with the object of afforestation who would advise through his staff private landowners and communities, should such apply for advice, and look after the training of British youth to meet the Forestry demands of the Empire. We do not mean to imply that this training should take place entirely in Great Britain, part of it no doubt could be done there especially if attached to the staff of the school was an officer with a life-long experience of British Forestry, of arboricultural conditions and estate management on a large scale, part of it could or rather would have to be done on the Continent, and for this it would probably be advisable to attach to the school an officer of some continental, *e.g.*, French, Forest Service with a good knowledge of English. If in addition to these was included in the school staff a man with a practical working knowledge of the utilisation of various forest products, who in addition to lecturing was in a position to take students to the centres of various forest industries and demonstrate on the spot practical utilisation or the means employed of rendering crude products fit for the market, then we would at once have the nucleus of a staff which for practical work and instruction would compare more than favourably with any continental college staff. Is it too much to hope that, before it is too late, something practical may be done in the way of systematic afforestation and education in Great Britain, and that useless posts and sinecures, academic discussion and futile committees and commissions may give place to a practical scheme of systematic afforestation and education under the control of one responsible head ?

GERMINATION OF TEAK SEEDS.

BY L. P. MASCARENHAS, ASSISTANT CONSERVATOR OF FORESTS, MYSORE.

In 1906, when I was in charge of Kakankote Range, I opened a nursery on the left bank of the river Kabbini near Kakankote.

Three kinds of seeds were used—

(1) Seeds soaked in cowdung for 15 days.

(2) Ordinary seed without any manipulation.

(3) Charred seeds collected from a burnt teak forest.

Each kind of seed was sown in separate beds to note the result of germination. The nursery was ready by the 5th of March and watering of the beds started, the beds containing the ordinary seeds getting the largest quantity of water (three times a day), and those containing charred seeds only once in the evening.

Profuse germination in beds containing charred seeds was observed within a fortnight and by the end of June the plants were nearly 1½′ in height with broad healthy leaves and a thick stem; at the end of April the seeds soaked in cowdung began to show signs of germination and the plants were only 6″ in height at the end of June; at the beginning of June the ordinary seeds germinated very sparingly and we could not get a handful of healthy and vigorous plants from these beds for planting purposes in July.

The above results seem to afford an important indication as to the best means to ensure regeneration.

Instead of using seedlings, often having to transport them long distances, and this frequently results in a large percentage of failures, the best method seems to be to prepare *raised* beds all over the burnt area where we wish regeneration, the number of beds depending on the size of the area, and sow charred seeds in these beds in May or even in the beginning of June.

The results promise to be successful, provided charred seeds are used; in July the seedlings can be removed from the beds and transplanted as desired over the area.

By this method expenditure on nursery and watering charges is obviated, and instead of using damaged and shaken seedlings, we will be using healthy and vigorous seedlings, which will probably develop into healthy trees.

EXPERIMENTS CARRIED OUT AT TANAKPUR IN JANUARY 1915 IN CONNECTION WITH THE ANTISEPTIC TREATMENT OF SLEEPERS.

BY R. S. PEARSON, I.F.S., FOREST ECONOMIST.

Reference should be made to a note giving results of similar experiments carried out in April 1914, at Kathgodam, the difference being that the sleepers treated in this experiment were very thoroughly seasoned, having been over a year out of the floating stream except those dealt with in Experiment VI, whereas those treated at Kathgodam had only been two months out of the floating stream.

The results obtained were as follows :—

I.

(*a*) Heart-wood sleepers, consisting of entirely heart and others up to one-third sap, the rest being heart-wood.
(*b*) Temperature 83°C., dropping to 52°C.
(*c*) Immersion 16 hours.
(*d*) Nineteen B. G. sleepers absorbed on an average 13·2 lbs. per sleeper.

II.

(*a*) Heart-wood, consisting of entirely heart and up to one-third sap, the rest being heart-wood.
(*b*) Temperature 93°C., dropping to 60°C.
(*c*) Immersion 19 hours.
(*d*) Nineteen B. G. sleepers absorbed on an average 14·4 lbs. per sleeper.

III.

(*a*) Heart-wood with no sap-wood in any of them.
(*b*) Temperature 93°C., dropping to 50°C.
(*c*) Immersion 20 hours.
(*d*) Eighteen sleepers absorbed on an average 16·6 lbs. per sleeper.

IV.

(*a*) Sap-wood sleepers, consisting of over one-third sap and the rest heart-wood.

(*b*) Temperature, started cold and gradually heated to 90°C. after 4 hours and allowed to cool to 82°C. at 5 hours.

(*c*) Immersion 5 hours.

(*d*) Twenty sleepers absorbed on an average 14·5 lbs. per sleeper.

V.

(*a*) Sap-wood, as in Experiment IV.

(*b*) Temperature 71°C., dropping to 54°C.

(*c*) Immersion 5 hours.

(*d*) Twenty sleepers absorbed on an average 17·1 lbs. per sleeper.

VI.

(*a*) Sap-wood sleepers only having been out of the floating stream 10 days and therefore containing an excess of moisture.

(*b*) Temperature 58°C., raised to 80°C. within 3 hours, allowed to cool to 65°C. in 5 hours.

(*c*) Total immersion 8 hours.

(*d*) Sixteen sleepers absorbed on an average 4·25 lbs. per sleeper.

CONCLUSION.

The conclusions arrived at from the above experiments are as follows :—

(1) That in consideration of the absolute air-dried state of the timber, 18 hours' immersion will be required for heart-wood lots, and that 5 hours will be necessary for sap-wood sleepers, whereas in the case of sleepers having been only 2 months out of the floating stream, as was the case with those at Kathgodam, 24 and 12 hours will be required for heart and sap-wood sleepers respectively.

(2) The maximum temperature advocated in the previous note was 85°C., and this is considered to still hold good. From experience gained in carrying out these experiments it is deemed advisable to commence reheating the oil before the sleepers are

removed, so that the next batch to be immersed should be put into the oil at a temperature of 60°C. To do so it may be found necessary to start the fire about ½ hour before removing the sleepers, the exact period being dependent on the extent to which the oil has cooled during treatment of the previous sleepers.

(3) The VI Experiment carried out with sap-wood sleepers only removed from the floating stream 10 days previously, took up only 4·25 lbs. each in 8 hours, which clearly indicates the necessity of further seasoning. The exact period required for seasoning before treatment cannot be stated with certainty as it will depend on the season of the year, though from experience gained at Kathgodam it will probably never extend to more than two months.

(4) In the note on the Kathgodam experiments, section 3-V, it was stated that the proportion of Green to Liquid Fuel oil should be as 48 gallons is to 52 gallons. As the Liquid Fuel oil now to be used has a specific gravity of ·85, the proportions should be as 7 is to 9.

(5) It was found while carrying out these experiments that some of the larger sleepers would not go into the crates, this might cause delay in loading, so that it might be possible to arrange that the last two upper rungs be made to slide in grooves to allow of the introduction of a certain proportion of thicker sleepers in each crate.

PRELIMINARY NOTE ON THE PREPARATION AND TREATMENT OF *XYLIA DOLABRIFORMIS* (JAMBA) PAVING BLOCKS AT THE KESRALGA SAW-MILL, NORTH DIVISION, KANARA, BOMBAY PRESIDENCY.

BY R. S. PEARSON, I.F.S., FOREST ECONOMIST.

(1) *General remarks.*

The object of the experiment is to find a market for Jamba (*Xylia dolabriformis*) timber which is available in large quantities in Kanara forests, but which being decidedly inferior to *Xylia* wood from Burma, owing to its faulty nature and liability to split, is at present not extensively exploited from these forests. The

experiment consists in preparing and treating 36,000 blocks, to be landed free of charge on rail in Bombay and to hand them over to the Engineering Branch of the Bombay Municipality to be laid in the road, at their expense, in order to give them a fair trial.

The blocks have been prepared at the Kesralga Saw-mill, under the direction of Mr. Dodgson, Divisional Forest Officer North Kanara Division, and the experimental treatment has been started by the writer.

(2) *Preparing the blocks.*

The blocks have been cut from girdled trees, which have been standing in the jungle for at least 10 years, so that the wood is thoroughly seasoned as is proved by the extraordinary regularity when weighing several hundred blocks. In converting the timber the number of faulty pieces is very large indeed, as not only are the logs very faulty but the timber has split very much in seasoning. The exact percentage of waste will be known when all the blocks are prepared and will then be recorded. At present it appears doubtful whether it will be possible to work Jamba for this purpose owing to the high percentage of rejections due to the above-mentioned causes.

The size of the blocks is 9 " × 3" × 5", the latter dimension being parallel to the grain. As regards the actual sawing of the blocks this can be done moderately well with ordinary circular saws, those in use which are for cutting sleepers are, however, so large-toothed that they give too rough a surface to the blocks. It is stated above that the blooks can be moderately well cut with common circular saws, but from the difficulty in keeping the surfaces accurately parallel and at right angles to each other it is quite evident that were the work to be carried out on a commercial scale that special block-cutting machinery would be necessary. This subject is now receiving attention.

(3) *Modification of original experiment.*

Before leaving the subject of preparing Jamba paving blocks it should be recorded that owing to the doubt which exists as to the possibility of working the Kanara Jamba for this purpose due to defective timber and consequently high percentage of rejections

Messrs. Bell, the Conservator, and Dodgson, the Divisional Forest Officer, in discussing the business with the writer, thought that probably an equal, if not better, opening would be found by preparing teak blocks from the very large quantities of waste material resulting from conversion of M. G. sleepers cut from butt and top pieces of teak logs, which are now lying at the present and old sites of the two portable saw-mills in the North Kanara Division. The supply would be very large and cartage of the waste stuff in all cases either nil or very low. The proposal is therefore to restrict the number of Jamba blocks to be supplied to 20,000 instead of 36,000 and to make up the balance with teak blocks, that is if the Municipal Engineers in Bombay will agree to this proposal. This they have agreed to.

(4) *Treating the blocks.*

The prepared blocks after being carefully selected were treated in Green oil by the open tank process. In order to arrive at some sort of an idea as to the amount of oil each block would absorb lots of ten were immersed in the oil and weighed before and after immersion. Owing to a mistake being made while heating the oil the temperature was taken too high, with the result that excessive splitting took place, the blocks warped and the amount of oil taken up was very irregular. It showed, however, that Jamba being a very dense hard wood presented great difficulties in treatment.

The following experimental treatments were carried out to ascertain absorption at stated periods of time :—

Serial No.	No. of blocks put in.	Weight before immersion in lbs.	Weight after immersion in lbs.	Difference in lbs.	Period of immersion in hours.	Temperature.
1	300	1,434	1,451	17	12	78°C.
2	300	1,427	1,438	11	12	80°C.
3	300	1,400	1,434	34	24	not known but probably about 80°C.
4	300	1,402	1,446	44	24	Ditto.

The above figures show that even with 24 hours' immersion the absorption is relatively low, it works out in the case of Nos. 3 and 4 to 1·7 lbs. per cubic foot. Looking to these results it is clear that treating for 12 hours is not sufficient and that the blocks will have to be treated for 24 hours in oil heated to not over 90°C. On this basis the rest of the blocks are to be treated.

EXTRACTS.

REGULATIONS FOR APPOINTMENT OF PROBATIONERS TO INDIAN FOREST SERVICE, 1915.

The following regulations for the selection and training of probationers for the Indian Forest Service are published :—

1. *Appointments.*—The Secretary of State for India in Council will, in the summer of 1915, make a number of appointments of Probationers for the Indian Forest Service.

In making these appointments, he will act with the advice of a Selection Committee.

2. *Applications for Appointment.*—Applications for appointment must be made on a printed form to be obtained from the Secretary, Revenue Department, India Office, Whitehall, London, S. W., and to be returned to him not later than *Thursday, the 1st July* 1915. Candidates must be prepared, if called upon, to attend at the India Office, at their own expense, for a personal interview with the Selection Committee within three weeks from that date.

3. *Age Limit.*—Candidates must be not less than 19 but under 22 years of age on the 1st January 1915.

4. *Nationality, etc.*—Every candidate must be a natural-born subject of His Majesty. He must be prepared to give an undertaking, if selected, that he will not marry before he reaches India. If he does so, he will forfeit his appointment. He must be of good physique, and must produce evidence of character to satisfy the Secretary of State for India in Council that he is suited for the Indian Forest Service.

5. *Qualifications.*—Candidates must have obtained a degree *with Honours* in some branch of Natural Science * in a University of England, Wales, or Ireland, or have passed the Final Bachelor of Science Examination in Pure Science in one of the Universities of Scotland.† A degree in Applied Science will not be considered as fulfilling these conditions. Candidates will be required to produce evidence that they have a fair knowledge of either German or French.

Note.—Applications for appointment will be accepted from candidates who on the 1st July 1915 have already sat at an examination for a degree as mentioned above, but have not learned the result of the examination.

6. Should there be more candidates considered to be qualified in every respect than vacancies to be filled, the Secretary of State reserves the right to require them to pass a competitive examination conducted by the Civil Service Commissioners, on the results of which their final selection would depend. Particulars of this examination, which would be held in August, will be found in Appendix I.

7. *Medical Examination.*—Selected candidates will be required to undergo a strict examination by a Medical Board at the India Office, at which particular stress will be laid on good vision and hearing, and to satisfy the Secretary of State for India that they are physically fit for service in the Indian Forest Department.

* A Moderatorship in Natural Science or in Experimental Science at the University of Dublin will be considered as fulfilling these conditions.

† Graduates in Forestry at the University of Edinburgh are regarded as satisfying the requirements of this paragraph if they pass the Final Examination of that University in some one branch of Natural Science embraced in the degree in Pure Science.

Candidates who do not satisfy the Secretary of State for India that they are physically fit for appointment to the Indian Forest Service will not be admitted to the competitive examination mentioned in Regulation 6.

8. *Period of Probation.*—Before appointment to the Indian Forest Department, a probationer will be required—

(i) to have obtained, either before selection as probationer, or within the period of two years' probation, the degree or diploma in Forestry at one of the Universities named in the margin; *

* Oxford, Cambridge, or Edinburgh.

(ii) to have undergone a special course of instruction in Forestry, under the direction and supervision of the Director of Indian Forest Studies, appointed by the Secretary of State for India in Council, in such British and Continental localities as may be selected for the purpose;

iii) to have passed an examination in certain special subjects, namely, Systematic Botany of Indian trees, Indian Geology, Forest Law, Indian Working Plans and, if required, an Indian vernacular language;

(iv) to have undergone a final competitive examination in Forestry (*see* Appendix II);

(v) to have satisfied the Secretary of State, in such manner as may be determined, of his ability to ride.

The period of probation will in ordinary cases be two years. The Director of Indian Forest Studies will instruct probationers in each case as to the order and manner in which they should fulfil these various requirements.

9. *Charges.*—The probationers will be required to defray all expenses of lodging, board, tuition, and excursions, while at the University, and on practical instruction in Great Britain and on the Continent, with the exception of fees payable to local forest officers in Great Britain and on the Continent.

10. *Allowances.*—The Secretary of State for India in Council will make payments to each probationer at the rate of £120 annually, not exceeding a total of £240 (besides the fees to local

officers mentioned above). These payments will ordinarily be made on the following dates in each year :—

		£
On the 1st December	... ...	30
On the 1st March	... ...	30
On the 1st June	... ...	60

The cases of probationers whose probation does not extend over the full two years will be specially considered.

The grant of the allowances is subject to the following conditions :—

(*a*) that the progress of the probationer in his studies is satisfactory;

(*b*) that the probationer gives security to refund the payments in respect of this advance, as well as such payments, not exceeding £60 in all, as may have been incurred by the Secretary of State on the probationer's behalf in respect of fees to local forest officers, in the event of his failing to qualify for an appointment in the Indian Forest Service, or not signing the articles of agreement as specified in paragraph 13, or failing to join the Indian Forest Service at the end of the period of probation.

11. *Conduct.*—Every probationer will be required to conduct himself during the period of probation in a manner satisfactory to the Secretary of State, and to give evidence of satisfactory progress in his studies in such a manner as may be required, failing which, or in the event of serious misconduct, he will be liable to have his name removed from the list of Probationers.

12. *Appointment and Seniority.*—Probationers who comply with the requirements of Regulation 8 within the sanctioned period of time, and also satisfy such other tests as may be prescribed, will be appointed Assistant Conservators in the Indian Forest Department, provided they are of sound constitution and free from physical defects which would render them unsuitable for employment in the Indian Forest Service. Their position in the provincial Forest Lists will be determined by the Secretary of

State for India in Council on the report of the Director of Indian Forest Studies; but in making selections for the post of Conservator, officers joining the service in the same year are reckoned as equal in seniority, unless the Secretary of State for India in Council shall for special reasons have directed otherwise in any particular case or cases.

Probationers will be allowed at the end of the period of probation to state their preference in respect to the Provinces to which they desire to be allotted; but the distribution will be made to the several Provinces according to the needs of the public service, at the discretion of the Secretary of State for India in Council. Officers are, however, at all times liable to be transferred from one Province to another at the pleasure of the Government of India.

13. *Articles of Agreement.*—A probationer is required, on qualifying for appointment as Assistant Conservator, to sign articles of agreement setting forth the terms and conditions of his appointment; he must embark for India when required to do so by the Secretary of State, and must engage his own passage. Failure to embark at the stated time will, in the absence of satisfactory explanation, lead to forfeiture of appointment.

14. *Passage Allowance.*—An allowance on account of passage to India will be paid to each probationer on appointment to the Indian Forest Service, to the amount of £37 10*s.* for passage to Calcutta, Madras, or Bombay, and £43 for passage to Rangoon.

Note.—The above is the normal rate of passage allowance. In consequence of the surtax of 10 per cent. at present charged by shipping companies in respect of passages to India the above rates of passage allowance have been raised to £41 5*s.* and £46 5*s.* respectively. Should this surtax be removed, these rates will be reduced to those given in paragraph 14.

15. *Salary.*—An Assistant Conservator of Forests will draw pay at the rate of Rs. 380 a month (equivalent to £304 a year, when the rupee is at 1*s.* 4*d.*) from the date of his reporting his arrival in India.

16. *Promotion, Leave, Pension, and Provident Fund.*—Promotion, leave, and pension will be governed by the regulations laid down by the Government of India, and applicable to forest

officers, such regulations being subject to any modifications or alterations which may be made in them from time to time by the Government of India, and their interpretation in case of any doubt arising being left to that Government. *A copy of the existing* regulations can be seen on application at the India Office.

SYLLABUS.

Languages.—The examination in German and French will include translation, composition and conversation.

Sciences.—The standard of the examination in Higher Chemistry, Physics, Geology, Botany, and Zoology will be that of the Honours Schools of the Universities.

The examination in Elementary Chemistry will consist of a written paper on the more elementary parts of Inorganic Chemistry together with outlines of Organic Chemistry.

APPENDIX II.—FINAL EXAMINATION.

1. With a view to the allocation of the annual Currie Scholarship for Indian Forest Students (value about £35), and to facilitate the allotment of probationers to the several provinces in accordance with paragraph 12 of the Regulations as to appointments in the Indian Forest Service, probationers who have completed their prescribed course of training will be required to undergo a competitive final examination in Forestry.

2. A list of the probationers in order of merit will be prepared by adding together (*a*) the marks obtained at the final examination, and (*b*) the marks obtained during the course of practical training in Forestry under the control of the Director of Indian Forest Studies. The maximum of marks obtainable under (*a*) will be the same as under (*b*).

3. The final examination will consist of an oral examination and three or more papers, as follows :—

(*i*) One or more papers in Sylviculture, Forest Protection (including Forest Botany and Forest Entomology), and Forest Utilisation (including Forest Engineering).

(*ii*) One or more papers in Forest Management, Forest Mensuration, Forest Valuation, and Forest Administration.

(*iii*) A paper in General Forestry (Practical) dealing with the work done and with the forests visited during the course of practical training.

4. The final examination will be held at the beginning ot October. Arrangements as to the date and place of examination will be made by the Director of Indian Forest Studies. Probationers will not be required to pay any fee for the examination.

A. T. SHUTTLEWORTH.

A MEMOIR OF HIS LIFE.

A correspondent writes:—On the 4th January 1915, there passed away, at Walmer, the spirit of Mr. A. T. Shuttleworth, in his 76th year, loved, respected and honoured by a large circle of friends, who considered themselves fortunate to call themselves such. His life was a remarkable one, even in these days, when nothing appears to be out of the common. A short account of it cannot fail to interest all, and may stir some to emulation, to follow in his footsteps and perform similar deeds of daring.

Born on the 21st October 1839, he joined the Indian Naval Service of the Honourable East India Company in November 1855, and arrived in India on the 21st April 1856. He served in the East India Company's Steam Frigate Ferooz, throughout the Persian War; was present at the landing at Hallilah Bay and at the bombardment of Bushire, on the 10th December 1856; as also that at Muhamerah. Later, he served on board H. M.'s Gunboat Clyde during the operations against the Waghirs in Okhamandel, and took an active part when Bet and Dwarka were bombarded. For his services in Persia he received the Indian General Service Medal, with the clasp "Persia." His eldest son, Major A. R. B. Shuttleworth, by a strange coincidence, is, at the present time, serving on the staff with the Indian Expeditionary Force in Arabistan.

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Forests in 1881, an appointment he held till April 1899, when he retired. He was a man of unbounded energy and activity which permeated his whole career. It is no exaggeration to say that whatever appointment he filled, he filled it with conspicuous ability. The Bombay Forest Department of to-day has been built up by him, and its present efficient state can be truthfully said to be the result of his untiring zeal and capacity for work and organisation. Mr. Shuttleworth was a splendid servant and steward to the Government. A better they could not possibly have found. It has always been a matter for surprise and regret among his many friends that his services received no recognition in the shape of honours or rewards, for no man was more deserving of them. His mind was singularly clear, and his judgment seldom at fault. He had the courage of his opinions and never feared to commit them to paper, even though he was aware that such would not be palatable or acceptable. It was possibly this trait in his character, which led to his claims being passed over. It, however, never deterred him from doing what was right. He was a staunch friend and generous opponent, bearing ill-will to no one even though their views might differ from his.

BRAVERY AT SEA.

His love and passion for the sea were boundless. His deeds of daring and bravery, in connection with life-saving at sea, are without parallel. During the rainy seasons of 1866—69, he was stationed at Alibag on the coast, just south of Bombay. Owing to the indifferent nature of the lighting of the west coast of India, at that period, wrecks were of frequent occurrence. Mr. Shuttleworth was not the man to stand by, looking on, when his fellow creatures, irrespective of colour, were in peril of their lives. They must be saved even though he perish. During the monsoon, as is well known, the seas run mountains high, but this did not deter him from putting off, in the ordinary native craft, manned by crews of Kolis, strengthened by their faith in him, to rescue ships in distress; he was thus the means of saving many hundred souls. The following are the names of some of the ships, to which he

rendered assistance :—Chapman, Zenobia, Berwickshire, Divernon, Vickerie, Themis, Tirzah, Bhowani, New Orleans and Oriental. It is not possible, in this short sketch, to give an account of each separately ; to prove their nature it is sufficient to give the recognition he received for his bravery.

HIS DECORATIONS.

He was awarded—

The Albert Medal of the First Class, by sign manual of the Queen " Presented in the name of Her Majesty, for gallantry in saving life at sea, wrecks of Berwickshire, Divernon and Tirzah, 1866 and 1867."

The Bronze Medal of the Royal Humane Society.

The Gold Medal of the Shipwrecked Fisherman and Mariners' Royal Benevolent Society.

The Silver Medal of Lloyds.

A vote of thanks with a record of his services, illuminated on vellum, by Lloyds, through H. M.'s Secretary of State for India.

A vote of thanks on vellum, by the Harbour Board of Bombay.

The thanks of the Royal Humane Society on vellum.

A Gold Watch by the Government of Bombay " as a testimony of his courage, skill and self-devotion in repeated and successful ventures at hazard of his life, to rescue the crews of ships wrecked near Bombay, in 1866 and 1867."

A Gold Chain and a purse of 400 guineas by the merchants of Bombay.

The late Mr. John Elphinston, I.C.S., who was the then Collector of Alibag, and rendered him great assistance, later became his brother-in-law.

Of late years, a regular Lifeboat station has been established at Alibag. One of the Lifeboats is named Louise Margaret after H. R. H. the Duchess of Connaught, while another has been called Allen Shuttleworth to commemorate this truly gallant and valorous gentleman.

HOME LIFE.

Perhaps Mr. Shuttleworth was seen at his best in the privacy of the home circle and among his large family, by whom he was greatly loved and honoured, and is now deeply mourned. He was a God-fearing man, and a true and earnest Christian, of which he was not the least ashamed, in fact, it was his joy. He was a believer in family prayers, never failing to hold them, morning and evening, and a regular attendant at church. He has had the privilege of being spared to see his family grow up around him and to uphold his name with honour. Of his family, he had every right to be proud, as they of him. He leaves a widow, seven sons and six daughters, to sorrow for him.

His sons are as follows :—

Major A. R. B. Shuttleworth, S. and T. Corps, at present on the Staff with the Indian Expeditionary Force.

Major D. J. Shuttleworth, 3rd (Q. A. O.) Gurkhas, serving on the Staff in India.

Captian B. W. Shuttleworth, 45th (Rattray's) Sikhs, Brigade Major in the New Army.

These three brothers are all graduates of the Staff College.

Captain (temporary Major) R. G. Shuttleworth, 110th Maratha Light Infantry, employed with the New Army.

J. T. Shuttleworth passed into the Army, but was rejected owing to defective eyesight. Now in business in Burma.

Dennis Shuttleworth, late of the York and Lancaster Regiment, was a temporary Captain in the New Army and has been Despatch Riding at the front.

E. H. S. Shuttleworth still at school, and not, as yet, old enough to serve.—[*Times of India.*]

TRANSMISSION OF CUTTINGS.

W. J. B.

The term cutting should be taken to include also "scions," or pieces of living branchlets used for grafting. It is more often possible to establish imported twigs as grafts on stocks of an older species of the same genus than it is to make them take root on their own account. In selecting pieces to send, they should, if from deciduous trees, be sent in the winter or leafless state, and they may be nine inches or more long. Growths well ripened and of average vigour should be chosen, neither too gross and sappy on the one hand, nor too weak and twiggy on the other. Shoots scarcely the thickness of a penholder are on the whole the most convenient size for grafting, and in cases where the one-season wood is much more slender than that, two-season shoots should be sent. Cuttings for rooting are nearly always made of one-season wood. Shoots of woody evergreens, like hollies or oaks, if to be sent long journeys, may have the leaves wholly or partially removed. One of the most important matters in connection with sending shoots for grafting or for cuttings is determining the right moistness of the sphagnum or other packing material. It should be moist but not saturated. The matter is, of course, dependent to some extent on the nature of the wrappings and their capacity for preventing escape of moisture, but the mistake of making the packing materials too wet is more often made than is the reverse.

A useful method, especially when the cuttings have to be sent long distances is to pack them in a ventilated box, with their ends (both top and bottom) bedded in clay balls, the middle part uncovered. The box should be of the right size to enable the cuttings to be packed across it all one way so that the clayed ends fit against the sides. In this way the uncovered middle part of the cuttings is in free air, and "sweating" is prevented.

Cuttings that arrive in a shrivelled but still living state should be submerged in water for a few hours to regain their plumpness.

Examples of genera, of which leafless cuttings for rooting may be safely sent long distances are: *Salix*, *Populus*, *Rosa*, *Ribes*, *Neillia*, *Spiraea*, *Tamarix*, *Cornus*, *Forsythia*. Root-cuttings, if the

collector can secure them, would be useful of such genera as *Rhus*, *Ailanthus*, and others with fleshy root.

As a general rule, leafless cuttings for rooting should reach England as soon as possible after the leaves have fallen. Grafts and root-cuttings need not arrive until spring. It need hardly be said that every precaution should be taken not to introduce in this way a new insect or fungoid pest.

Leafy summer cuttings of hardy trees and shrubs have been very successfully transported from America to England in the month of July. The cuttings were tied in small bundles of half a dozen or so and laid loosely in shallow baskets with damp moss about the stems, the leafy parts being left uncovered. The basket was then tied down with canvas. It is, of course, only possible to send over cuttings in this way by arranging with the purser or other officer on board ship that they may be kept in the cool storage. For hardy things it was found that a temperature of about 42° Fahr. was very suitable. Cuttings ten days in transit have been found to root well, but perhaps a fortnight is about the limit for this class of cutting—KEW BULLETIN.—[*Tropical Agriculturist.*]

THE RINGING OF TREES.

The following extract from an article by MR. L. A. BOODLE in the KEW BULLETIN No. 6 of 1914 should prove of interest to tropical planters :—

The effect of ringing differs in different kinds of trees. Various experiments have been made, and a study of the results of the operation proved useful in the early days of plant physiology in leading to a knowledge of the route of conduction of water and of elaborated food-substances in plants. Experiments in ringing were made by MALPIGHI and RAY, of whom the latter mentions that a holly tree lived for several years after a ring of bark of a hand's breadth had been removed from the stem so as to leave the wood bare. Since this early observation numerous experiments have been made on several kinds of trees, and form two classes, *viz*.:—(1) bark-ringing, *i.e.*, the stripping off of a ring of bark as in the case

mentioned above ; and (2) wood-ringing, *i.e.*, making an annular cut into the stem through both bark and part of the wood.

Bark-ringing.—The effects of bark-ringing depend upon the interruption of the bark and the exposure of the wood. The break in the continuity of the bark prevents the normal conduction of elaborated food-substances (albuminous and carbohydrate) from the parts above the ring-gap to those below, since these bodies are ordinarily conveyed through the bark (or more precisely the phlœm). Hence, if there are no leaf-bearing branches on the stem below the point of ringing, starvation of the roots ensues. This may be slow, seeing that there is a store of food in the bark of the roots and of the base of the trunk to draw upon, but the growth and absorptive powers of the roots will eventually be checked, and in some cases the functional failure of the roots may be the final cause of the death of the tree.

The exposure of the wood, where the bark has been removed, introduces other factors endangering the life of the tree. The supply of water for the upper part of the tree has all to pass through the wood at the level of the ring-gap and from several causes the conducting power of this wood tends to become more and more curtailed until the requisite amount of water can no longer pass through it. Owing to the surface of the wood being in contact with the air, the outer layers of wood become dry and useless for conduction. This alone may soon render the water supply insufficient in species with only a thin zone of sap-wood, since true heart-wood is incapable of conducting the transpiration stream. On the other hand, "sap-wood trees" (*i.e.*, those which form little or no heart-wood) can usually survive the operation of ringing for a long time, *e.g.*, several years. Among these the progressive drying of the wood from without inwards may finally restrict the area of functional wood until it reaches the critical point, or this result may be accelerated by a fungal disease attacking the wood and rendering some of it useless. Again, in trees which form heart-wood, the production of this accounts for the loss of a certain proportion of the wood available for conduction. While no new wood is added at the level of ringing, and functional wood is lost

externally by drying, there is a further loss internally owing to the yearly conversion of some sap-wood into heart-wood.

To summarise, bark-ringing eventually causes the death of the upper part of the tree, because the water supply becomes inadequate, either through loss of conductivity in the wood at the level of the wound, or through deficiency of absorption by the roots.

An interesting example of bark-ringing may be quoted here. A forked pine-tree was chosen by HARTIG for an experiment. The tree was 118 years old, and the trunk was forked at 4½ m. above the soil into two approximately equal stems. The bark was peeled off all round one of these stems at about 3 m. above the point of forking. When the tree was felled 18 years after this ringing operation had been performed, it was seen that the crowns of both stems were still sound, but that the foliage of the ringed stem was thinner and weaker than that of the other stem. It was also found that growth in thickness had practically ceased after ringing on the side of the trunk situated below the ringed branch. The reason for the long-continued life of the ringed stem is that the roots attached to the base of the trunk on the side below the intact stem had received normal nourishment, and therefore, having remained healthy, had been able to supply the trunk with a good supply of water.

Wood-ringing.—The experiments in wood-ringing made by STRASBURGER and others show that, though the inner (older) layers of sap-wood can conduct water for the transpiration current, the heart-wood cannot do so. The first of the following cases serves as an example of a sap-wood tree, the remainder being "heart-wood trees" (*i.e.*, trees which form heart-wood).

Two beech trees 150 years old had trunks 32 cm. in diameter. These were ring-cut to a depth of 8 cm., and the trees still bore foliage a year and a half later.

The trunk of an oak 50 years old was ring-cut into the heart-wood, and its foliage withered in a few days. Another oak of the same age, which was cut similarly but not quite through the sap-wood, did not wither for some weeks.

The trunk having been cut to the heart-wood in a tree of *Prunus avium*, and in a *Robinia*, wilting of the leaves took place in two days in the first case, and in a few hours in the second.

Various other experiments and observations have been made in bark and wood-ringing, but enough has been quoted to illustrate the nature of the results obtained in this way.—[C. D. in the *Tropical Agricright*.]

EAST INDIA TEAK.

(From the annual review by Messrs. Foy, Morgan and Co.)

On the sudden outbreak of war, the trade came to a stand-still for some weeks, nobody knowing what the effect on business would be. Teak buyers became very apprehensive lest the London market should be flooded with diverted shipments of goods sold to Germany, and in addition to this, the tension caused by the unfavourable financial position naturally produced by the war caused considerable embarrassment to dealers in such a costly article as teak. It is not surprising, therefore, that the demand from August to November showed a considerable diminution, and prices suffered to some extent. As events have shown, however, the German teak contracts which had to be cancelled in consequence of the war were only for very moderate quantities, and therefore the apprehensions of buyers that the market might be flooded proved to be groundless, but it was not until December that confidence began to be restored. By this time the financial outlook had improved somewhat, and with a growing demand in certain quarters for teak, prices recovered, more especially for planks of small averages, in which a considerable business for forward shipment was done. The reports of the present floating season, although as yet incomplete, hold out no hope of large supplies during the coming year; and in spite of the fact that nothing can be shipped to Germany, and also that shipments to Belgium cannot recommence until after the war is over, there is not much prospect of more teak being forthcoming than the market can comfortably consume. The steady demand which

exists at present is chiefly in consequence of ship-building requirements, consequent on the demand for fresh tonnage, while orders on account of rolling-stock work are much lighter than usual at this time of the year, for the reason that some of the largest manufacturers are fully engaged at present with Government work which does not call for the employment of teak. As soon as these special requirements of the Government are satisfied, there may possibly be a rush of orders from rolling-stock manufacturers which may make a heavy inroad upon the landed stocks. In these circumstances, we anticipate a steady maintenance of present prices during the early part of the coming year, with the possibility of a rising market later on.

Burma and Siam Logs.—From Moulmein the business has practically ceased, nothing having been received during the whole year. From Rangoon there has been a remarkable diminution, less than 500 loads having been received, as compared with 2,600 loads during the previous year. On the other hand, there has been a very large increase from Bangkok, the total quantity being more than double that of the previous year. *Planks.*—The quantities imported from Burma are almost the same as those of the previous year, while the importations from Bangkok again show a falling off, and in fact are less than they have been for some years past.—[*The British Trade Journal.*]

THE BEST TIME FOR CUTTING TIMBER.

We usually speak of "winter cut" timber as the best, and some give as a reason that it contains less moisture. This is hardly the case. On the contrary, some authorities claim that many woods contain quite as much, if not more, moisture in winter than in summer. The principal reasons why winter cut timber should be preferred are that it is harder and denser, not so susceptible to the attacks of forest fungi, and capable of being more perfectly seasoned. The most rapid growth of timber is in the early summer, and this is the poorest time for cutting. Winter and late autumn cutting seasons are the best.—[A. J. FRYE in the *Timber Trades Journal.*]

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We publish in two parts an address given by Mr. H. R. MacMillan of the Canadian Forest Service

ON

THE PRESENT CONDITIONS OF APPLIED FORESTRY IN CANADA.

PART I.

The individual Canadian is even more interested in the application of principles of forestry to the management of timber lands than is the individual citizen of the United States. The manufacture and marketing of forest products is of greater relative importance in Canada than in the United States. The estimated total value of the forest products of Canada was for the year 1912 $182,300,000, or an annual wealth production of $25·68 per head of population. The total value of the forest products of the United States is, of course, much greater than the total for Canada, being estimated at $1,280,000,000 for the year 1908. Annual wealth production *per capita* in the United States is therefore only $13·70. The forest as a source of wealth and a support of industries is almost twice as important to the Canadian as to the American.

From the earliest days of settlement the forest has played a very important part in the foreign trade of Canada. In 1913 12·1 per cent. of the total exports were of forest products, the value for the year being $5·97 per head of population; in the same year in the United States the products of the forest constituted only 6·3 per cent. by value of the total exports of that country, averaging $1·37 per head of population.

The Canadian public meets a large share of its expenditure with revenue derived directly from the sale or leasing of cutting rights to publicly-owned timber lands, and from royalty and stumpage payments made upon timber so cut. The revenue derived from this source in 1913 totalled $7,700,000, exclusive of taxation on privately-owned timber lands or mills, slightly over $1·00 per head for the entire population of the Dominion. This is a very large revenue to be derived directly from forest lands by a community containing no more people than the State of New York.

The prominence of the forests in the industries, trade and the public finance of Canada is in no way due to the precocious development of forest industries at a rate disproportionate with other industries. Neither is it due to the rapid exploitation of timber upon lands which later will be devoted to agriculture or other uses.

The forest plays an important part in the life of Canada, because the forest offers the only important source of livelihood over an overwhelming proportion of the land area of the country. The total area of Canada omitting the north-west territories, comprising the whole land area north of the 60th parallel, a sub-arctic region of 1,242,224 square miles, which cannot for many years become even an unimportant source of timber, is 2,487,441 square miles. Of this a total of 1,524,000 or 61 per cent. may be classed as valuable chiefly for the production of forest crops. It will be many generations before the remaining 39 per cent. is devoted exclusively to other uses than the growing of timber.

It could confidently be expected that any community which depended to such an extent for its livelihood, trade and public

revenue upon any resource as Canada does upon the forest would from financial consideration, take early measures to assure the careful protection and permanent productive capacity of that resource. While Canadians may claim to be pioneers to two of the essentials of State forestry, retaining title and timber land and undertaking fire-protection, they cannot claim to have grasped the problem seriously and taken advantage of their early lead by recognising timber as more than a temporary crop and endeavouring to administer the absolute forest land for another crop of timber.

The public lands of Canada are owned and administered, in part by the Dominion Government and in part by several of the Provinces. The present status of forest administration can be understood only after a discussion of the six important timber administrations.

The Dominion Government owns and administers the remaining public lands of the Provinces of Manitoba-Saskatchewan and Alberta together with an area of 19,000 square miles in British Columbia. The total area so administered was originally 778,000 square miles. In accordance with principles holding good over Canada no lands known to be timbered were ever sold or allowed to be homesteaded. In this part of Canada settlement on timbered lands has not been attractive so long as prairie could be secured, and this fact in conjunction with an inspection of homesteads before the issuance of patents has prevented the taking up of any important areas of timber land by settlers. Up to the present 250,000 square miles of Dominion public lands (as these are known) have been alienated. Of the remainder 125,000 square miles, part of which is wooded, is estimated to be agricultural. The remaining 400,000 square miles is non-agricultural land still owned by the Crown. The jurisdiction over this land is divided between an organisation without forest ideals and an organisation with forest ideals, the latter and more modern and progressive branch of the service fortunately securing each year a greater control. The whole area was originally administered by a Timber Branch, an organisation for policing the timber

resources. Lumbermen or speculators desirous of securing the right to cut timber explored the country, applied for such tracts as they desired. These tracts were put up for sale; the highest bidder secured a license to cut timber, renewable in perpetuity so long as he paid the annual rental of five dollars per square mile. The holder of this license is not required to cut. The duties of the Timber Branch are confined to the work of selling the timber, the prevention of trespass, the checking up of the quantities of timber cut and the collection of the royalty reserved upon the timber and payable when it is cut. This royalty is fifty cents per thousand feet on all classes of lumber and may not be charged. The officials of the Timber Branch now cruise tracts of timber before putting them up for sale and set a reserve price which is a protection to the public in cases of lack of competition.

The license which the purchaser acquires contains certain conditions which give the Government the right to take all steps necessary to control or regulate the logging operations for the purpose of producing another crop of timber and ensuring complete utilisation. These provisions which make effective forest management legally possible are at present a dead-letter, because the enforcement is left to the Timber Branch which takes little or no interest in this aspect of forest administration. A feature of these regulations is a provision forbidding the cutting of any timber less than 10 inches in diameter. This regulation is not uniformly enforced. It is almost without exception unsuited to the types of forest occurring on Dominion forest lands and to the methods of logging which must be practised where the average stand is not over 4,000,000 feet to the square mile. The staff of the Timber Branch consists of clerks and 12 to 20 forest rangers and cruisers whose duties are chiefly police duties.

The scarcity of merchantable timber in the 400,000 square miles of wooded Dominion lands is reflected in the comparatively small area, 8,342 square miles, upon which rights have been granted for the cutting of timber. Because of the inaccessibility of these timber lands and the low grade of the product, which

can be sold only when both markets and transportation are good, the annual cut is very small, being 385,000,000 board feet for 1912.

During the last fifteen years there has grown up in the Department of the Interior, which administers Dominion lands, a Forest Branch, the pioneer Forest Service of Canada. The first work of the Forest Branch was the governing and distributing of nursery stock for planting on wind-swept prairie farms. This work has grown rapidly and successfully. A study has been made of the care and development of the tree species suitable to the prairie. Two large nursery stations have been developed and altogether 20,000,000 trees have been furnished for farmers' wood-lots and shelter-belts.

The forest area on Dominion lands has suffered more severely from fire than any other in the Dominion, probably nine-tenths of the total acreage has been burned over during the past sixty years. The Timber Branch took no responsibility for fire-protection. The Forest Branch since its inception has endeavoured to build up a fire-protective organisation commensurate with the problem. The fire-protective situation is one of the most difficult which the world affords. The provincial laws under which the work is carried on afford little or no support. The hazard is widespread over thousands of square miles, the forest is in dry seasons extremely inflammable, the population is sparse, the transportation facilities are very poor and the public sentiment, as expressed by the ex-premier of one of the Provinces, is the familiar one of "Get the timber out of the road." The territory is too big for expenditure on permanent improvements, there is little chance of extinguishing fires except along main-travelled roads, there is no law against the setting of fires throughout the summer for land clearing, therefore educational and police work alone is possible. This is attended to by a staff of 130 temporary rangers employed each summer and working under direction of about 15 permanent fire rangers. The average area of forest land to each forest guard is 3,000 square miles. As a matter of fact, the guards are concentrated in the regions of greatest hazard, there are

many areas as great as ten or twenty thousand square miles where fires occur and there are no forest guards.

The Forest Branch has been steadily engaged in classifying lands in advance of settlement with the object of setting aside non-agricultural lands as permanent forest reserves. Already 27,931,482 acres of forest reserves have been established by Act of Parliament and may be changed only by Act of Parliament. The examination of lands is still going forward and the area of forest reserves annually increased. Any agricultural areas which may be included within forest reserves are not open for settlement.

Though the Forest Branch undertakes fire-protection on public timber lands outside the forest reserves, whether held under timber lease or not, it does not administer any lands outside forest reserves. The forest reserves are chiefly burned over lands and contain very little timber, not more than 2½ billion feet. The greater part of what they do contain is held under timber licenses acquired previous to the establishment of the forest reserves and not under the administration of the Forest Branch. The reproduction on the forest reserves is as a general rule good, chiefly lodgepole pine, aspen and jackpine. The administration of the forest reserves up to the present has consisted of fire-protection and the prevention of trespass. A staff, organised after the pattern of the Forest Service, is being organised. An inspector has charge of the reserves in each Province; a supervisor is in charge of each reserve, the unit varying from 100 square miles to 7,500 square miles. The field work is carried out by the supervisors, rangers and forest assistants. There is a movement under way, as yet unsuccessful, to place the Forest Branch under the Civil Service Commission which will result in appointments and promotions being made for merit.

Very little timber is cut from Dominion forest reserves. The total cut in 1912 was about 7,000,000 feet, one-half of which was cut by settlers and the other half by timber operators. The total timber revenue of the forest reserves was in 1912 $21,000.

The chief duties of the staff are fire-protection, administration of grazing (there is fine summer range), supervision of small

cuttings, and the introduction of more valuable species. For a generation at least the expenditure must greatly exceed the revenue from timber. Though the region will not be a national source of timber, the expenditure is justified if it assures a cheap supply of timber to the important prairie farming region.

The Dominion Railway Commission is another branch of the Dominion Government with administrative duties affecting forest administration. There are 29,300 miles of railways in operation in Canada, of which about 10,000 miles operate through forest country. The Board of Railway Commissioners have drawn up an effective set of regulations requiring railway companies to keep the right-of-way free of inflammable material, burn only certain grades of fuel, patrol the right-of-way according to a schedule fixed by the Board after field inspection, maintain locomotives in a non-fire producing condition, actively fight fires which may occur. The Board has placed the field administration of this order in the hands of the administrative branches of the various Governments interested and employs a chief inspector to supervise the work. As a result of this system fires starting from railway rights-of-way are no longer a serious menace. Few fires start, and those which do start are promptly controlled. The railway companies have been led by this order to appoint special officers to look after fire-protection.

(*To be continued.*)

NOTES ON GRAZING, BASED ON OBSERVATIONS MADE DURING A PERIOD OF PRACTICAL TRAINING IN THE FORESTS OF THE CENTRAL PROVINCES.*

BY M. M. ALI BEG, ASSTT. CONSERVATOR OF FORESTS,
HYDERABAD STATE.

The excessive demand for grazing and its bad effects on the soil, forest growth and cattle, necessitating revision of the Working-Plan, have already been dealt with in detail. It

* [We have been asked to insert this article being the first effort of a young Indian Officer in this direction. We do so with some hesitation as its interest is limited while the phraseology is at times involved.—*Hon. Ed.*]

now remains to show the procedure adopted by the Working-Plan and the Revenue Officer, specially appointed, to study the grazing question by inspecting the forest areas that supply grazing, by collecting statistics, etc., and to prepare a grazing scheme for the Division under which the possibility should be fixed, the available grazing distributed and measures for maintaining the revenue which is likely to fall in consequence of restrictions on grazing adopted by fixing suitable rates. It is also worth while to give the methods suggested for the administrative working of the scheme including the collection and check of grazing revenue.

COLLECTION OF STATISTICS.

The above-noted officers examined the registers of 1910, obtained from the license-vendors, to find out the number of cattle sent to graze in the Government forests in 1910. It is found that these were not sufficiently accurate to allow of any safe forecast. They therefore abstracted grazing statistics range by range for the year 1911 from the current registers of all license-vendors. In some places the Rangers, assisted by the Revenue Inspectors under the Special Revenue Officer, abstracted these statistics. The statistics thus obtained showed that 93,690 head of privileged cattle, 46,750 of ordinary cattle and 15,881 buffaloes were grazed in 1911, giving a total of 156,321 and no cattle were charged as commercial. I find that the difficulties of obtaining accurate statistics were as many as, if not more than what I experienced in the case of the grazing report on the two villages in Yellandu.

INCIDENCE ADOPTED.

It is found from the statistics obtained that during 1911 the average grazing incidence for the forest division as a whole was *1·9 acres* per animal, though in many blocks it was as heavy as *2 animals* to the *acre.*

The continuation of this state of affairs can only result in the obliteration of the forests and the rapid deterioration of the local breeds of cattle, and a marked superiority was noticed in

the stall-fed cattle in the open country to the animals in those heavily grazed areas where excessively cheap grazing had led to the reckless and promiscuous breeding of large herds which are turned out in thousands to find out what sustenance they can in the Government forests. Hence it was thought that the number of cattle allowed to graze should be limited. But no authoritative opinion based upon data as to what the incidence of grazing on the two types of soil—metamorphic and trappean—generally found here should be, could be obtained; it is observed that on trap the damage and denudation caused by grazing are much less than on the metamorphic; moreover, in the Grazing Circle sylvicultural considerations are of minor importance and the number of cattle need only be limited to what the forest will support for the four months of the rainy season. Hence for the above reasons it was suggested that a 3-acre incidence should be adopted on trap, 5-acre on metamorphic and 1½ acres per animal in the Grazing Circle. But the Government considered that a 5-acre incidence is more than is necessary on metamorphic and fixed an incidence of 3 acres for this formation along with continuous closure for fifteen years after felling, at any rate, until experience has proved these provisions allow for the due maintenance and improvement of the forests.

The grazing experiments conducted in this Division, along with the information I collected about the period during which cattle are admitted to the forests for grazing, provide certain data on which to base the incidence.

GRAZING SEASON.

The custom here is that cattle are sent out to graze in the latter part of June and are stopped from grazing by the end of Diwali, *i.e.*, the latter part of November. Roughly it may be said that the animals graze for about six months. It has been found by experiments that a cow or bull consumes about 5 seers of grass in about 8—10 hours and that the average outturn of 1 acre on trap soil is about 1,000 lbs., thus a 3-acre incidence gives about 3,000 lbs. or 1,500 seers, while a cow consumes about

900—1,000 seers of grass in the six months. This gives a nominal surplus of about 600 seers which, however, does not exist owing to wastage of grass due to trampling, etc., which cattle do not touch and also for poor grass almost always present on the area, which is also not eaten by cattle. Hence a 3-acre incidence is quite a good one for trap. It is found by experiment that the metamorphic formation yields about half the quantity of grass obtained on trap. Thus a larger grazing unit of area is necessary for metamorphic.

As regards buffaloes, it is found by experiment that one consumes twice as much as a cow, so that the incidence has to be increased, but I believe buffaloes to some extent eat the waste grass spoken of above.

However, the above is a method of fixing the incidence in the absence of accurate data, which are very rough only as based on the amount of grass consumed by stall-fed cattle, which is probably much less than that consumed by cattle at large in the forest.

SUPPLY OF GRAZING.

The Working-Plan Officer divided the whole forest into three Working Circles which, for the purposes of grazing, may be classified into two parts—the Grazing Circle which is intended mainly for the supply of grass and fodder and in which there is no closure except to sheep and goats, and the Felling Circles which are worked for the supply of timber and fuel in which sheep and goats are entirely excluded and which have either continuous closure for a period of fifteen years after felling in the Mixed Working Circle with a rotation of 45 years, or closure and opening of coupes in alternate periods of five years until the extent of time during which closure is enforced has reached a period equal to one-third of the rotation (30 years) in the Teak Working Circle, so that one-third of the area in the second part is always available for grazing and the whole of the first part—the Grazing Circle.

The Revenue Officer inspected the greater part of these circles seeing the condition of the forests and was satisfied with the

areas assigned to each circle. The two small patches about which the Working-Plan Officer had been uncertain were transferred by mutual consent from the Felling Circle to the Grazing one. The Working-Plan Officer had had a large area taken from the old Grazing Circle and put into the Felling Circle. The Revenue Officer agreed to this step. They found some small open patches in the Felling Circle which would probably bear no forest growth, and on the other hand some rather valuable patches of forest occurring in the Grazing Circle. But it would have been impossible for them to find a practicable boundary line to separate such patches, hence these areas were left as they were and the distribution between the Felling Circle and the Grazing Circle has thus been a fair compromise.

The Working-Plan Officer had proposed the exclusion from Working Circles of 14 isolated patches of Government forest to be treated as grass *birs*. They have a small area of 9,320 acres, and even if they are all opened to grazing they would not hold more than 5,000 cattle; this would not relieve the situation to any great extent while their preservation as *birs* will be far more economical and ensure the supply of fodder to more than 5,000 animals. The Revenue Officer agreed to this proposal and suggested that all of these except three should be treated commercially; the Government orders, however, are that all of them are to be dealt with from a commercial point of view.

POSSIBILITY FIXED AND JUSTIFIED.

Adopting the incidence of 3 and 5 acres as the minimum from a sylvicultural point of view and extracting the figures unit by unit, it was found that only 90,300 head of cattle could be admitted as compared with 156,300 actually grazed in 1911. This would have entailed heavy exclusion and the incidence in the Grazing Circle was therefore reduced to 2 or 1½ acres as it was found that the animals cannot thrive on less even for only four months in the rains. Moreover, it is hoped that even in areas open to grazing there will remain some teak, thorn and other trees to provide *nistar* (timber, fuel, etc.), for the neighbouring villages. It is calculated

that grazing can be provided for 808,000 privileged and 19,300 other cattle, as against 93,690 privileged and 62,631 other cattle grazed in 1911. Of the latter it is found from the statistics obtained that 4,641 head including 1,152 privileged cattle *had come* to graze *from other districts*, thus only 11,700 head of privileged cattle from the Nagpur and Wardha districts will be excluded. From the statistics obtained in the Divisional office it has also been observed that only 87,800 privileged cattle grazed in 1908, 80,000 in 1909 and 75,900 in 1910, giving an *average* of only *84,000* for four years, including outside privileged cattle.

Moreover, from the District Gazetteer of Nagpur and Wardha it has been found that the total number of cattle, (excluding goats and sheep,) owned in the two districts in about 1905-1906 was 699,000 and goats and sheep, 256,000. The total number of cattle, (except sheep and goats,) has perhaps increased since then and may be taken as not less than 700,000. Of this number only 150,000, excluding outside cattle, actually grazed in 1911 and provision has been made as pointed out above in the Working-Plan for 100,100 (80,800 privileged + 19,300 other). Hence exclusion will therefore amount to about 50,000 which is approximately about 7 per cent. of the total number owned (700,000). The percentage would be even less on the figures of previous years from which it appears that the total number grazed was 148,000 in 1908, 130,000 in 1909 and 136,000, in 1910. From the above figures it is evident that grazing has been found hitherto for more than 550,000 outside the Government reserved forests, and it is thought that it will not be impossible to find it for 50,000 more. Nor is it unreasonable to expect the people to reduce their unnecessarily large herds. Moreover, it is clear that grazing in Government forests can be dispensed with and is not required in the case of hundreds of villages in the open tracts of both Nagpur and Wardha from which not a single animal is sent to graze. Besides this, the surplus cattle can either be sold or sent elsewhere without any restriction on agriculture, especially when it has been found that in some cases a fair proportion of them, about five times what it should be, are bulls.

Of 256,000 sheep and goats only 13,000 grazed in Government forests in 1911 or roughly five per cent. If other arrangements can be made for 243,000, then it should also be possible to provide for the grazing of these 13,000. Hence in the interest of the forest growth and also of other cattle, the grazing of goats and sheep is not provided for.

SMALL EXCLUSION OF PRIVILEGED CATTLE JUSTIFIED.

As already pointed out, provision has been made for the grazing of 11,700 less privileged cattle than the 92,000 actually grazed in 1911 which figure was 16,000 more than that for 1910 when only 76,000 were grazed. The very few villages from which privileged cattle were sent to graze in 1911, but which have not been included in the grazing units, lie for the most part at a distance from the forests, in open country, surrounded by other villages from which no cattle resort to the forests. The presumption is that the owners, rarely of the poorer class of cultivators, are better able to make provision for stall-feeding their cattle. It has been actually found that a Malguzar had sent in the year 1911 80 head of privileged cattle, while not one of his tenants had sent a single animal. Moreover, the privileged cattle of the excluded villages will still have access to the distant forests of the East and West Pench ranges (not heavily grazed) and there will be a possibility of their admission also in the nearer grazing units.

PROVISION FOR BUFFALOES.

If previously existing orders are to be literally and strictly carried out, then the forests of the Division can provide grazing only for the privileged cattle and a small proportion of the ordinary cattle. But in some ranges good breeds of cattle as well as large numbers of buffaloes were sent to graze. The villages adjacent to the forests have already been especially favoured in respect of their privileged cattle and this is as it should be. The lists obtained show that a small number of privileged cattle sent from distant villages has been excluded owing to the admission of good breeds of cattle and buffaloes, while the ordinary cattle

usually grazed have nearly always been the excess cattle of the village neighbouring on the forests. The lists obtained from license-vendors show that the more distant villages with few exceptions send only cattle at privileged rates and those in small numbers village by village. With a view to providing grazing for the full number of privileged cattle from more distant villages the Revenue Officer has restricted grazing in all ranges to 1,400 head of ordinary cattle and 15,500 buffaloes.

GRAZING UNITS.

It might have been expected that the Grazing Circles would have been separately formed into grazing units owing to intensive grazing being allowed in these, but the boundaries are frequently not well marked on the ground, and as regards the boundaries marked even though they are readily understood by the Range Officers and coupe contractors they are not understood by ordinary graziers. Thus 13 units out of 34 consist partly of Felling Series and partly of Grazing Units or *nistar* areas. The Revenue Officer and the Working-Plan Officer think that this will not lead in practice to a heavier grazing incidence in the open coupes than laid down as the maximum, because the graziers will naturally concentrate more cattle in the Grazing Units than in the open coupes owing to there being far more grass in the former than in the latter.

With the exception of the Pench ranges the forests of the Division are not continuous and extensive but occur in patches. In forming Grazing Units therefore isolated blocks of forest are taken and made into separate units if sufficiently large; in some cases groups of separate blocks have been made into single units, and, where suitable boundaries could be found, the larger blocks have been divided into one or more units. Altogether 34 units have been formed. Excluding the two large units in the Pench ranges made up of the unworked felling series, there are 32 units with an average area of 18 square miles. The units are smallest where the grazing has been most intense in order to ensure its wider distribution. Outside the Pench ranges also there are a few

large units, two of 33 and 30 square miles respectively and one of 34 and one of 27. The Revenue Officer remarks that it has not been found necessary or feasible to subdivide these, as they are large continuous blocks of forest and the villages from which the cattle will be admitted to graze in them are distributed fairly evenly round their perimeter.

The allocation of different villages to the various units has been by far the most difficult part of the work. First information had to be abstracted from each license-vendor's registers showing the number of privileged and other cattle sent to graze or for which licenses to graze had been taken out. These lists had to be compiled range by range, for all licenses were not taken out by the cultivators of one village at one time nor always from one license-vendor as is prevalent now. Then Grazing Units, having been fixed as above, and the numbers assigned to them according to the possibility determined as above, the most suitable number had to be entered on the range list. This work required the assistance of Range Officers, their assistants and Revenue Inspectors and maps had also to be constantly referred to. Every village entered in the lists was traced by the Revenue Officer on the map. Having thus obtained a primary distribution by units, it was ascertained how far grazing could be provided in each for the cattle ordinarily sent from the villages included in it. In all cases the villages actually adjacent to each unit have been retained in it, but it has not by any means been always possible to admit villages, not so adjacent, to the nearest units. Exclusive of goats and sheep, the total number of animals sent to graze has been considerably greater in 1911 than in any of the three previous years as shown above, and therefore it is anticipated that when some of these are required to go further afield for their grazing than they have done this year they will arrange to do without it altogether. Based upon these, notes upon each grazing unit, with the lists of villages from which privileged and in some cases other cattle may be admitted to grazing in each, are prepared ; and six tracings, one for each range, showing the boundaries of units, the position of villages, etc., have also been prepared.

The formation of one mixed unit with different grazing incidences had been criticised by the Commissioner and the Conservator, but it was assumed by the Government that the Revenue Officer and the Working-Plan Officer have combined units in order to avoid re-demarcation and consequently considerable delay in the issue of the plan. Further, it is quite possible that the existence of mixed units will not result in excessive grazing in the open coupes in practice. Hence the Government sanctioned the constitution of 34 units, the allotment of villages to, and the limitation of grazing in, each unit as detailed in the notes for each range but subject to an incidence of 3 acres instead of 5 acres in the Pench ranges. The Government further remarked that if the experience of the next few years proves the grazing in the open coupes of any one or more of these units to be excessive it will always be open to the Conservator to make proposals for further subdivision.

ADMINISTRATIVE WORKING.

The Revenue Officer suggested some measures as regards the manner in which the fixed incidences are to be enforced, and the issue of permits for grazing in particular units is to be regulated. In many units there will be room only for the privileged cattle of the selected villages and in many others for the privileged cattle of the selected villages and a small proportion of other cattle. Hence copies of the unit lists with the tracings should be sent to each Range Officer. The Range Officer should warn the villages to take out their licenses before the end of June to avoid disappointment. License-vendors should also be given instructions as regards the Grazing Unit in which they are to issue licenses and also the number of privileged and other cattle allowed, and licenses issued are to specify units and, if possible, boundaries. It was also suggested that there should never be more than one license-vendor to issue license for any unit, otherwise the incidence cannot be kept within the limits laid down; further, that no precedence should be given to the privileged cattle of selected villages after the first of July.

Each license-vendor knows the maximum number of privileged cattle admissible in each unit, and, if licenses have not been taken out for that number by the 1st of July, he is to be permitted to issue licenses for others up to the maximum. The Range Officer must also warn villages from which cattle have formerly been sent to graze in his range, but which have not been included in any of his unit lists, that they should make other arrangements, but that some grazing may still be available if they apply after the 1st of July.

RATES.

The Revenue and the Working-Plan Officers were instructed to submit proposals as regards rates charged for grazing.

PRIVILEGED CATTLE.

In the event of proposals for the restriction of grazing being accepted at a maximum privilege rate of two annas as laid down in the recent Secretariat order there would be a considerable loss of revenue. The total grazing revenue for the past three years, (excluding sale of grass,) was Rs. 35,000 in 1908-1909, Rs. 29,000 in 1909-1910 and Rs. 27,000 in 1910-1911, this may be expected to diminish considerably if there be no increase in rates.

As shown already, the incidence was 1·09—1·9 acres per head and it is now 3 acres so that cattle will obtain 2—3 times as much sustenance as they used to get. But I may point out this is only in the Felling Circle.

After due consideration the Government has fixed 3 annas for privileged and 10 annas for ordinary cattle from which buffaloes are excluded.

COMMERCIAL CATTLE.

For these an arbitrary fee of Re. 1 for cows, bulls and bullocks and Rs. 2 for buffaloes has been laid down.

COLLECTION OF GRAZING REVENUE.

The Government rules for the license system with differential rates for agricultural and other cattle have defined the privileges

the methods of issuing passes by the patwari and of license-vendors and of the issue of licenses on the production of these passes by the agriculturists. The most important part of the work of realising grazing revenue is the determination of the number of cattle for which owners are to be given licenses at privileged rates. The privileges granted by Government entitles—

(1) the agriculturists to graze four cows, bulls or bullocks per working plough at privileged rates and an equal number at ordinary rates ;

(2) the agricultural labourers and village servants to graze two cows, bulls or bullocks each at privileged rates, provided that in both cases cattle are actually owned by the above classes. Calves born in the calendar year in which licenses are taken are also allowed to graze free when accompanied by other cattle.

ACTUAL WORKING OF THE SCHEME.

The restrictions prescribed in the grazing scheme are briefly as follows :—

(1) The formation of grazing units, the subdivision of each unit into portions where grazing is prohibited and those in which grazing is allowed, the allotment of grazing in these units to villages which adjoin or hitherto have depended on the units. The cattle from these villages are allowed to graze in these units only.

(2) The shutting out of cattle which hitherto have come from villages at a distance.

(3) The limiting of the maximum number permitted for each unit so as to give an incidence of one head per 3 acres in areas under regeneration fellings and one head per $1\frac{1}{2}$ to 2 acres in areas fit for pasture only.

(4) The conversion of certain grazing blocks into grass *birs* in place of others, formerly *birs*, now absorbed into grazing units.

In August 1912 orders were received sanctioning the grazing scheme under which the grazing of village cattle was restricted to particular units. These villages are mentioned in the plan,

but the number of cattle allotted to each village is not given, though for the group of villages it is. During 1912-1913 therefore only restriction (1) was entirely carried out, restrictions (2) and (3) were partially carried out by diverting the cattle from villages at a distance to grazing units where the pressure of grazing was not excessive and by raising the incidence from one head per 3 acres to one head per 2 acres. Restriction No. 4 was also partially carried out by opening half of the *birs* where the grazing demand was heavy. The above special arrangements were necessary to prevent panic among cattle-owners. For the year 1913-1914 restrictions (1), (2) and (4) have been entirely carried out, while in respect of (3) the excess of cattle over the sanctioned number was further reduced. Statements showing for each grazing unit the number of cattle that actually grazed last year and the villages they came from were prepared and the cattle that belonged to distant villages (restriction 2) and those which only sent up a few head were excluded. The remainder was taken to represent the number that should be allowed to graze during the current year. The number thus fixed for each unit was equitably distributed over each of the villages allotted to each grazing unit. Some ranges had numbers less than the sanctioned limit, these were left out of consideration; as regards the others, the reduction proposed amounted to 9 per cent. on the last year's actual numbers and about 30 per cent. of the excess over the sanctioned limits. The statements alluded to above could not be obtained with the requisite amount of accuracy from the license-vendors before April 1913, and the numbers assigned to each unit and each village were therefore announced through the Mukaddams by the end of April. There was still time for them to make arrangements to send their excess cattle to the forests which are not over-grazed but they did not do so. When therefore licenses were refused, they were in a state of consternation, as the excluded cattle were starving. The Divisional Forest Officer therefore suggested that the percentage excluded should be readmitted at commercial rates only for the four months of July, August, September and October. This was agreed to by the Conservator and the Commissioner, and it was

decided that the number of cattle should be reduced to the prescribed limit in the various units gradually over a period of about three years.

The grazing question as discussed above is of great importance in this division, and it will lose all its horrors if the people are sensible enough to understand the restrictions and try to reduce the unnecessary herds of cattle which the rich villagers are generally proud of possessing. If this idea of wealth, manifested in the number of cattle a rich landholder possesses, can be removed from his mind, the grazing difficulties will be half overcome.

EXTRACTS.

PROFITS FROM FORESTS.

Many European towns and cities own considerable areas of forest lands, and as these are in almost every case under the constant care and supervision of qualified foresters they are a source of steady profit to the communities. An example of this is cited in recent forest notes by the U. S. Department of Agriculture, which states that Zürich, Switzerland, derives an annual income of $7·20 per acre from her forests, which results in a reduction in the taxes of $32,000 each year.—[*Scientific American.*]

MERCURY AS A PLANT GERMICIDE.

A new method of destroying plant and household pests and for fungus diseases has been devised by Mr. Franz X. Bickel of Kufstein in the Tyrol, according to a recent number of the *Chemiker-Zeitung*. In inclosed spaces the mercury is employed in

the form of vapour. In other cases it is injected in metallic form directly into the circulating fluids of the plant. The growth of the plant is not only not disturbed, but is in most cases actually assisted. When a tree is treated the process is as follows:—With a stout 3-millimeter auger holes are bored in the lower branches—from 5 to 7—in an oblique direction and passing through the pith. These holes are then filled with mercury by means of an ordinary "dropper," after which they are made air-tight with "tree-wax" or some similar substance. From 2 to 7 grammes of mercury are required for an inoculation. The effect is quickly observable and continues for a year or more.—[*Scientific American.*]

FORMOSAN CAMPHOR INDUSTRY.

Attention has from time to time been drawn in these pages to the conditions of the camphor industry in Japan and Formosa which, as is fairly well-known, is worked on the monopoly system. Under this system the purchase and sale of camphor and camphor-oil became the exclusive business of the Government; the manufacture of camphor is restricted in quantity and the permission to manufacture is granted to manufacturers, from whom the Government takes delivery of the article and gives compensation therefor. This system, it may be remembered, came into force in Formosa in 1899. But as is explained, in an official publication issued from Tokyo, "after the coming into force of the camphor monopoly system in Formosa there was an extraordinary rise in the price of camphor; consequently the camphor industry, which had been for a long time in a depressed state in Japan proper, suddenly became very active and with the increased output the price of camphor suddenly fell. Then came the necessity of putting in operation a camphor monopoly law which should have equal force in Formosa and Japan; and in October 1903, the crude camphor and camphor-oil monopoly law was also enforced in Japan proper." The extent to which Japanese refined camphor dominates the principal markets was discussed in an article published in the *Indian Trade Journal* of 12th February 1914.

In his latest Report Mr. Consul Harrington has a great deal to say on the condition of the camphor industry in Formosa in 1913. The export declined from 8,649,319 lbs. worth £553,550, in 1912 to 7,860,854 lbs. worth £495,720 in the year under review. It went to the following countries:—

	1912. lbs.	1913. lbs.
United States	2,370,289	3,597,273
France	943,536	1,373,564
United Kingdom	1,003,086	1,229,647
Germany	2,243,366	1,048,295
Japan	1,693,969	598,847
Austria-Hungary	72,783	13,228
India	322,290	...
Total	8,649,319	7,860,854

It will be seen that the countries of destination have varied in their amounts very largely. Allowing for the decrease to Japan, the total quantity exported to other countries showed an increase.

The total production of camphor during 1913 was 5,999,538 lbs., to which must be added 3,573,602 lbs. of camphor re-manufactured from 7,405,438 lbs. of camphor-oil, making the total output for the year 9,573,140 lbs. Considerable stocks were in hand at the end of 1913.

The future of the camphor industry continues to excite some apprehension owing to possible exhaustion of the existing camphor forests and the tendency to diminution has been officially admitted. It is, nevertheless, claimed that present resources are sufficient to maintain an annual supply of about 6,500,000 lbs. for 18 years, and that by then the afforestation scheme will be far enough advanced for that quantity still to be produced. In 1913 about 3,000 acres were planted with 3,813,000 trees at a cost of £3,500 and as the scheme is to be continued for 12 years, large additions will be ultimately made to the existing reserves. It does not appear that many important new camphor forests are likely to be discovered, as the tree does not flourish more than 4,000 ft. above

the sea, so that the mountainous interior will probably contribute but little.

Every attention is being made to render the method of production more efficient. In addition to distilling from the leaves of the camphor tree, efforts are being made to utilise profitably the dwarf camphor tree, which ordinarily produces very little camphor. Again, the 7,000 stills used throughout the country have been or will be rebuilt to give more efficient results.

For 1914 the estimated production of camphor is 6,500,000 lbs.

The export of camphor-oil increased both in quantity and value, being 4,842,549 lbs., worth £172,620, against 4,475,908 lbs., worth £159,410 in 1912. The whole export went to Japan.

The total production was 7,545,019 lbs., but, as mentioned above, a large quantity of camphor-oil was re-manufactured. The re-manufacture of camphor-oil leaves as by-products brown oil, white oil, linalool, etc., which were exported to the value of £16,800.

The estimated production of camphor-oil during 1914 is about 8,400,000 lbs.—[*Indian Trade Journal.*]

FOREST TRAMWAY PROJECT, COCHIN.

In the concluding chapter of his *Report on the Administration of Cochin* for the year 1913-14 (1089 Malayalam Era) the Diwan of the State makes the following observations on the *Forest Tramway project*:—Of the many problems that are now under consideration, I need only refer to one which, from the general interest it has always aroused and from the large capital involved, is of prime importance to the State. That problem is the Forest Tramway. It has been for some years recognised as a difficult question and has caused much anxiety, but it is now reaching an acute stage and calls for a solution more insistently. It is now possible to forecast, though of course approximately only, the net financial result of this adventure. In 1082 the Tramway was opened for transport. At the end of 1088, the capital and recurring expenditure on the Tramway stood at Rs. 28,17,962, while the total

value of the forest produce carried by the Tramway, after deducting the incidental charges of felling, loading, etc., of timber at the end of that time amounted to Rs. 14,87,826. At the ordinary rate of working, the more valuable timber, which alone it can pay to transport by the Tramway, will be exhausted in about four years more, probably the end of 1093, and it is patent that no other rate of working, unless it be heavier exploitation, will pay, considering the large running expenses of the Tramway. On the other hand, the carrying capacity of the Tramway limits the rate of working. From 1089 till the end of 1093, taking the average of the past seven years, the gross value of the transported forest produce may amount to about Rs. 11,00,000. In this period, the maintenance charges of the Tramway (also on the average of the past) would amount to about Rs. 6,25,000. The total expenditure on the Tramway both for capital and recurring charges and the total value of the forest produce carried by the Tramway, deducting incidental collection charges, from 1082 till 1093, when under ordinary circumstances the Tramway would cease to work, would roughly amount to 34 and 26 lakhs of rupees respectively in round figures. Thus the net result, as far as can be seen at present, will be the total depletion of the State's existing stock of valuable teak and rosewood in the area served by the Tramway at a large cost to the State; in other words, the State will have had to pay for destroying its valuable timber in this area. The Tramway's future presents a problem of no little difficulty.—[*Indian Trade Journal.*]

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FURTHER NOTES FROM OLD PUNJAB FOREST REPORTS.

BY B. O. COVENTRY, I.F.S.

In the *Indian Forester* for November 1914, an article appears under the title 'Notes from Old Punjab Forest Reports,' and in the concluding paragraphs the writer makes certain remarks criticising the progress of the Department in the Punjab. That these remarks are only too true will, it is believed, be admitted by most officers in the Punjab who have had experience of Divisional work. This want of progress is undoubtedly partly due, as has been suggested by the writer of the article, to the unwieldy size of the Conservator's charge, but it is also due to the uncontrollable size of the Divisional or controlling charges. As far back as 1871 the strength of the controlling staff in the Punjab was 21 officers, whilst the present sanctioned scale of the controlling staff is 11 Imperial and 10 Provincial Service officers. There has thus been no increase in the strength of the controlling staff since the early days of the Department, while the work of controlling officers has steadily increased to such an extent that the Conservators and the Divisional Officers have more work than they can cope with

which renders progress practically impossible. The Department may in fact be considered to have reached the climax of what is possible with the present strength of the controlling staff.

That there is ample scope for the further development and progress of the Department, which would result in a large increase in revenue from the forests, provided the controlling staff is strengthened, no one who knows the forests will hesitate to admit. During the last few years much discussion has taken place in the Forest Conferences with regard to the deodar forests, and from the information brought forward it is very apparent that the working of the deodar forests is far from satisfactory, and it is now generally admitted that it will be necessary to introduce more scientific sylvicultural systems of treatment, which will not only facilitate the regeneration of the forests, but also yield higher financial results. With regard to the Chir Pine forests in the Rawalpindi Division, a revised working-plan has recently been drawn up in which the working-plan officer has shown that the yield from the forests can be double that of what was under the old plan, by introducing a more scientific method of treatment, but at the same time he has made it clear that the system advocated could not be successfully carried out unless the Division is split up into smaller controlling charges. The Turpentine industry is only in its infancy, and shows possibilities of great expansion in the future when tapping operations can be extended to all Chir Pine forests in the Province, but here again to make a success of the undertaking very careful control and supervision will be required to ensure the best results being attained and to prevent harm being done to the forests. The Blue Pine forests have scarcely been worked and afford scope for future development, and the Fir forests of which there are vast areas have not yet been touched and are likely to yield considerable revenue in the future. Much could be done to extend the areas under deodar, and in the formation of plantations of valuable species such as pencil cedar, walnut, etc., which would result in yielding higher revenue in the future. There is also probably scope for making better use of forests in the low hills and on the plains, especially the irrigated

plantations, and in the utilisation of minor products. Much could also probably be done to reduce the cost of extraction of timber, to prevent waste by improved methods of conversion and to reduce the loss of timber by breakage in the rivers. Apart from the possibility of progress as exemplified by increased revenue, there are other matters of vital importance, especially with regard to the meeting of the requirements of the local agricultural population, the working of the rivers, the training of the subordinate establishments and so on, which show ample room for improvement.

The above remarks are sufficient to indicate briefly that the Department in the Punjab has by no means reached the end of its resources, and that there is considerable scope for further improvement and progress.

Measures have from time to time been taken to reduce the work of controlling officers such as for example by the giving up of Departmental working, the attaching of assistants to the Division, the delegation of powers and so on, but although such measures have relieved controlling officers of part of their burden, they have not resulted in the progress which might have been expected. The reason for this is obviously due to the fact that the controlling charges are too large in area, for it is essential if the best use is to be made of the forests that controlling officers should be intimately acquainted with the forests under their charge, the local conditions and requirements of the local population, which is not possible under the present arrangements, owing to the too large size of the charges, which is accentuated by the difficulty of travelling and the frequency of transfers. Consequently the adoption of measures to reduce the work of controlling officers which do not involve a reduction in the area of their charges, cannot be expected to result in any marked progress of the Department.

The principle originally adopted for fixing the size of the controlling charges was to make them coincide with the Civil Districts and this arrangement has been more or less adhered to up till the present time. This arrangement was probably the most suitable one which could have been adopted in the early days

of the Department when the general organisation of the forests was in progress, but since many years it has failed to meet the requirements of the Department, with the result that progress has not taken place to the extent to which it should have done. The only apparent reason why the strength of the controlling staff has not kept pace with the requirements of the Department appears to have been due to the extra expense which would be involved, it not having been sufficiently recognised in the Punjab, as has been done in other Provinces, that extra expenditure incurred in strengthening the controlling staff would result in increased revenue. Apart however from their value as a source of revenue, the proper working of the forests for protective purposes and for supplying the requirements of the agricultural population should not be overlooked. Whereas the surplus cash revenue as shown by the Annual Report for 1913-14 was Rs. 4,31,779 the value of forest produce removed by right-holders was estimated to be Rs. 27,10,745. Judged solely from a commercial point of view it is not easy to justify the additional expenditure which would be incurred on splitting up the Divisions, as it is not easy to prove by figures that this would be at once followed by a correspondingly increased revenue, but that this result would be attained sooner or later is certain. It is probable, however, that a falling off in the surplus revenue could be obviated, if necessary, by a reversion to Departmental working, and by the curtailment of expenditure in works such as roads and buildings until a sustained increase in the revenues sufficient to meet the additional expenditure which would be incurred in splitting up the Divisions has been obtained.

The four Divisions most urgently in need of splitting up are the Rawalpindi, Kangra, Kulu and Bashahr Divisions, which it is considered should be split up into three, two, three and four Divisions respectively if they are to be efficiently managed. It would be out of place in this note to attempt to give details of the manner in which it is considered that the Divisions should be split up, but it may be remarked that it would be false economy to adopt half measures, such as by forming two Divisions where there

should be three or more, as this would simply result in increased expenditure without being compensated for by sufficiently increased revenues or other marked progress. That there is ample scope for very considerable progress being made in the furture both with regard to financial results and in the general management of the forests is unquestionable, but in order that progress may be made it will be essential to introduce more intense and skilful working of the forests which will only be possible provided drastic reforms in the existing organisation are undertaken, involving the formation of at least two Circles and the splitting up of the Divisions into smaller controlling charges; and until this is done there is little or no prospect of any further material progress being attained.

ON SOME FOREST MATTERS.

BY E. M. HODGSON, I.F.S.

1. *Standards in Coppice areas.*—The fuel forests of Madras Presidency referred to by Mr. Fischer in the *Indian Forester* would appear to be similar in type to the scrub jungles of the Gokak Range, Belgaum Division, for which a working-plan has been recently made.

The following extracts will give some idea of the conditions prevailing and the reasons for reserving (or not reserving) standards :—

Average rainfall 33·5 ; **rock** quartzite, conglomerate, sandstone or gritstone ; **soil** sandy, shallow, full of boulders and extremely poor. **Ground cover,** spear grass, lantana and prickly pear, either separately or together. **Principal species,** Mashwal (*Chloroxylon Swietenia*), Tugal (*Albizzia amara*) and Dindal (*Anogeissus latifolia*). **Injuries,** fires, overgrazing, hacking, prickly pear and lantana. **Requirements of the market,** fuel and small building wood (the forests are incapable of producing large timber).

Method of treatment adopted. It has been decided to adopt the coppice-with-standards system throughout, with the exception that in a few coupes where the growth is very old or injured, and

suitable reserves are not available, simple coppice will be substituted for the first rotation only: the reasons for this decision are given below :—

(1) The constitution of the forests is largely uniform and the proposed methods are the only ones in this case by which the objects sought will be easily attained.

(2) The proposed system is very elastic. If the growth is good numerous standards are reserved; if poor the reservation must needs be sparse; if very old or unsound a clean sweep and a fresh start are indicated.

(3) The cuttings prior to 1912, as well as in coupe 1 of most of the blocks suggested in this plan, also fellings in similar and neighbouring Native State forests, all prove conclusively that the principal species, and most of the subsidiary ones, not only coppice vigorously but reproduce well, too, from seed, provided the exploited area is protected.

(4) The system is simple to work, and will not interfere with the grazing and other privileges exercised by the villagers: it may be admitted, however, that simple coppice throughout would be still easier, and a workable system; but the advantages of reserving standards are real; they decrease the injury from any fires (by retarding a rank growth of grass), shed useful seed, facilitate germination, shade young growth from the sun and produce the largest timber of which the forests are capable. In other words, standards greatly increase the value of the forest. In the adjoining Sangli State forests the sanctioned plan prescribes reservation of standards. Local demand will be well satisfied, and the villagers of all forest villages given a steady amount of labour annually. Distant markets will, after the satisfaction of local requirements, obtain as much as the forests can produce.

From the above it may be gathered that the reservation of suitable standards is considered beneficial to the forest, but that no gain is expected from retaining decrepit trees. The shade from the larger standards in the Gokak forests is not negligible, but I agree that crooked and stunted trees when cut are generally replaced by far heavier shade-giving shoots. In spite of the miserable soil it is truly wonderful what a large number of seedlings are establishing themselves—some from seed of standards, others from seed dropped during the fellings—since an improvement in protection from fire and grazing has been established.

As regards quality of timber I think the system adopted will give satisfactory results: it is lack of protection more than defect in system that needs guarding against.

Standard reservation admittedly increases work and needs considerable supervision—three parties are at work throughout the year in Gokak Range—but besides the advantages enumerated in the plan the operations undoubtedly force the subordinate protective establishment to perform much inspection that would ordinarily be shirked. The regular cuttings are carefully controlled, and as the trees are small few standards are broken. Cleanings and weedings are unnecessary in these jungles. Work of this nature is carried out in the vastly more important Nagargali High Forest, and is far more troublesome, and more open to criticism, than standard reservation.

Further south in the Belgaum and Khanapur Ranges the forests are of a very superior type, and there are strong arguments in favour of reserving even bad trees, when better are not available. A large, old branched tree is often fit for fuel only, will give poor coppice, or none at all, and costs much more to convert than a well-grown tree: consequently a contractor gladly leaves such uncut. But though bad from a timber point of view, a tree of this class performs two of the chief duties of a standard, *i.e.*, helps to keep down the grass and to assist natural regeneration from seed; and where fires do immense damage shade is of prime importance. The timber produced in these forests is not inferior except in so far as it has suffered from hacking, fires and cattle. After all, or

nearly all, the good trees have been reserved as standards the remainder, if some teak are present, fetch a high price: a 100 acre coupe bringing in nearly Rs. 30,000.

2. *Climber-cutting.*—The local people believe that a climber, like a tree, reproduces more freely when cut near the ground, but that if cut 2ft. high or so it may die. The cut climbers in this Division frequently put out shoots and need repeated cutting back. In many cases when the climber has wound round the stem the cut ends do not spring far apart, hence it is conceivable that new shoots might sometimes be assisted in climbing by the proximity of the upper dead portion.

3. *Subsidiary results of fire-protection.*—Though ticks are bad in the west and south of the Belgaum Division, where 90 to 100 per cent. of the forest is now unburnt, the question of stopping protective measures on this account has not, and is not likely to be, considered. There is no record to show whether these pests were less in evidence in the days when all the forests were burnt annually.

METEOROLOGICAL OBSERVATIONS AT CHANGA-MANGA.

BY R. N. PARKER, I.F.S.

In the *Indian Forester* for January 1915, pp. 6—13, the results of the first complete year's observations at Changa-Manga are given and a short account of the observatory and reasons for its establishment will be found. The following tables give the figures recorded during the year 1913-14 :—

Mean Maximum Temperature.

1913-14.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	96.7	96.9	99.1	94.7	81.6	69.5	71.5	69.3	81.2	93.6	104.6	105.2
Lahore Station B	96.9	97.0	98.9	95.2	82.3	69.7	71.0	69.1	80.7	93.1	104.7	105.2
Changa-Manga	97.7	97.4	98.2	93.3	81.1	69.5	71.2	69.3	81.0	93.4	103.2	104.5
Montgomery	99.8	100.1	99.8	95.3	82.5	69.9	70.7	69.0	81.7	94.4	107.2	108.5

Mean Minimum Temperature.

1913-14.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	79.3	79.5	72.0	61.4	49.3	43.5	45.5	47.5	54.4	64.9	75.4	82.2
Lahore Station B	79.2	79.3	72.0	61.4	49.1	42.9	44.5	46.3	54.2	65.0	75.4	82.4
Changa-Manga	76.1	75.4	66.7	55.3	43.8	37.2	39.5	41.6	47.1	57.0	66.0	75.6
Montgomery	80.3	80.9	73.5	64.4	53.1	44.4	46.0	45.4	54.7	67.0	78.4	84.6

Mean 10 hours' Temperature.

1913-14.	July.	August.	September.	October.	November	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	88·6	88·9	89·3	83·2	69·8	57·4	58·6	58·7	70·6	83·8	94·8	95·8
Changa-Manga	88·8	88·5	86·6	80·8	67·4	56·6	58·3	57·7	69·0	80·7	92·3	95·2

Mean 16 hours' Temperature.

1913-14.	July.	August.	September.	October	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	93·6	94·7	97·7	92·3	78·6	66·5	69·4	67·2	78·8	91·3	102·8	103·4
Changa-Manga	98·0	95·9	97·0	92·2	79·3	68·5	70·1	67·5	79·8	92·6	101·5	102·1

Highest Maximum Temperature.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	1913-14.
Lahore Station A	104·8	104·4	103·1	102·6	87·3	79·1	77·9	77·9	95·4	110·7	117·6	117·6	
Lahore Station B	104·9	104·4	102·9	102·9	87·4	78·9	77·9	76·9	94·4	109·1	117·6	117·6	
Changa-Manga	104·1	103·7	102·2	101·9	86·8	78·5	78·3	82·9	94·5	109·2	114·8	113·5	
Montgomery	105·9	106·4	103·4	103·4	90·0	77·6	79·4	78·7	95·6	110·4	120·7	117·4	

Lowest Minimum Temperature.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	1913-14.
Lahore Station A	70·2	71·2	63·5	55·6	42·7	32·8	39·9	40·1	47·2	58·2	59·0	70·7	
Lahore Station B	70·2	71·2	63·7	55·7	42·7	32·7	39·9	40·1	47·2	58·2	59·0	70·7	
Changa-Manga	67·6	68·3	57·3	49·0	35·5	25·9	32·0	32·3	38·3	49·5	53·0	68·6	
Montgomery	68·0	74·0	67·8	57·0	45·8	33·7	40·0	36·7	46·5	55·8	61·5	72·5	

Mean Relative Humidity from the Mirimum.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	83	84	81	76	82	86	87	86	77	73	60	67
Changa-Manga	94	93	96	95	97	98	97	92	93	91	85	87

Mean Relative Humidity at 10 hours.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	65	64	48	37	44	63	64	67	47	39	33	45
Changa-Manga	67	66	60	50	54	67	63	67	56	47	45	50

Mean Relative Humidity at 16 hours.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Lahore Station A	56	55	35	38	36	49	44	46	32	28	23	33
Changa-Manga	56	54	45	39	42	44	38	43	38	28	36	44

Rainfall.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total.	1913-14.
Lahore	7·55	8·70	0·27	0·10	...	0·40	1·09	1·54	0·38	0·98	1·14	0·90	23·05	inches.
Changa-Manga	4·57	3·38	1·86	0·10	...	0·58	1·52	1·40	0·44	0·68	1·33	0·86	16·72	inches.
Montgomery	2·63	2·01	2·06	...	0·23	0·38	1·14	0·34	0·11	0·66	...	0·08	9·64	inches.

CONDITIONS OF APPLIED FORESTRY IN CANADA.

BY H. R. MACMILLAN, CANADIAN FOREST SERVICE.

PART II.

(*Continued from page 177 of the* Indian Forester.)

Ontario is one of the most important forest provinces of Canada. The area of the Province is 407,000 square miles of which 260,000 is fit for no other use than growing timber.

A large proportion of the land classed as potentially agricultural land is still covered with forest.

The policy of administering timber lands in Ontario has not changed greatly in thirty years. The lands timbered and non-timbered are administered by a Crown Lands Department, consisting of an office staff, a number of district crown timber agents' offices employing cruisers, forest rangers, with police duties, scalers and fire rangers. The Department employs a Provincial Forester and assistant who have no administrative duties.

All public lands in Ontario are wooded, the stand depending upon the degree to which it has been burned. The public lands are open both to purchase by timber operators and speculators, homesteaders and land purchasers. Neither the settler nor land purchaser is allowed to acquire title to valuable bodies of pine timber.

Settlers and land purchasers are not taking up important areas of timber lands in Ontario. There is no classification of land by the Government to prevent settlers or land purchasers taking up non-agricultural lands to the detriment of the community.

The system of handling public timber is simple. Cutting licenses are sold which entitle the holder to what are apparently perpetual cutting rights over the area purchased upon payment of $5·00 per square mile rental, and a royalty payable when the timber is cut which varies from fifty cents per cord in the case of pulpwood to $5·00 per thousand on some recent sales of white pine. These licenses are sold by auction, the person willing to pay the highest cash bonus secures the license. There are at present

17,519 square miles of licenses held chiefly for white pine and pulpwood. The amount of timber cut from these licenses was 360,000,000 board feet of pine, 64,000,000 board feet of other timber and 131,000 cords of pulpwood.

The sale of timber on public lands in Ontario is unaccompanied by any thought of the permanent productivity of the forest. No study is being made of the forest lands to learn their productive capacity, no restrictions are placed upon cutting operations to even encourage close utilisation or bring about conditions conducive to forest reproduction of any kind. The white pine stands are treated as a mine from which a certain amount of ore is extracted each year. The quantity of pine remaining on Government lands is estimated at 12,000,000,000 board feet. The quantity on licensed lands while unknown is probably at least as great. The quantity of pulpwood remaining is enormous. No forest survey has been made of the Province.

Forest reserves covering nearly 21,000 square miles have been created. The object is to hold certain valuable bodies of timber for sale, to create recreation parks or perhaps in accordance with the idea which once prevailed in New York State to create a forest "reserve" for the future. The forest reserves receive no administration beyond policing and fire-protection.

Ontario was a pioneer in fire-protection. At present large sums of money are spent. The Government employs fire rangers on the forest reserves, along railways and on certain public timber lands carrying valuable stands of timber. 585 were so employed in 1913 at a cost of $233,000. Holders of timber licenses are required to employ men to protect their licenses and the Government supervises their work. License-holders in 1913 employed 350 men. Logged over lands, thousands of square miles of white pine and other reproduction, on non-agricultural land, secure no protection. The expenditure of money is restricted to the merchantable crop. Studies made by the Commission of Conservation have shown that the Province is losing millions of dollars annually by failure to protect the young growth on white pine lands which are even now in the centre of markets. Adjoining a

densely settled portion of the Province 260 square miles were burned over out of a total area of 2,100 square miles in 1913. The Province rarely hires men to fight fires and rarely prosecutes for infractions of the fire law. The annual loss from fire would prove staggering if it were investigated.

Though no attention is paid to maintaining a forest cover on public timber lands which are being deforested the Provincial forester is carrying on planting operations on abandoned farm lands which the Government has acquired in old settled portions of the Province. 1,500 acres of land have been acquired and are being reforested. 2,000,000 forest tree seedlings have been distributed to farmers and others for woodlet improvement. The public of Ontario received a direct revenue of $2,127,000 from timber in 1913. The expenditure on the administration and maintenance of this resource was $398,000.

Quebec is now the largest Province in Canada. The total area is 707,000 square miles of which 530,000 square miles is valuable only for the growing of timber.

Almost the same system of public timber lands administration has been followed in Quebec as in Ontario.

The policy of the Government has been to retain ownership to timber lands. Many years ago when this policy was not in effect several million acres of timber lands passed into private hands. This was in recent years swelled by the taking up of timber land under homestead for the timber value. In order to prevent this as far as possible a blanket forest reserve covering 162,000 square miles has been placed on unalienated forest lands.

Timber is sold in the same manner as in Ontario. Licenses to cut are sold at public competition by the Crown Lands Department. The licenses are perpetual, the annual rental is $5·00 per square mile, the royalty, payable when timber is cut, varies from 2·00 per thousand, in the case of white pine and hemlock, to $1·05 per thousand feet in the case of spruce, hemlock and balsam. There are now about 70,000 square miles of timber held under license. The annual cut from licenses is about 900 million feet.

Since 1906 a Forest Service has been in process of development in Quebec. Though the Forest Service has nothing to do with the sale of timber land it performs an important work in the inspection of logging operations. Licenses issued to timber purchasers by the Crown Lands Department now carry restrictions requiring clean logging and specify diameter limits of 13 inches for pine, 12 inches for spruce, hemlock, maple and birch and 8 inches for balsam and swamp spruce, below which trees may not be cut. Though these diameter limits are the same for each species over the Province and are based upon insufficient data they indicate a desire on the part of the Government to handle the timber lands in such a manner as to increase their productivity. There are no regulations requiring slash disposal.

The classification of land is now a part of the duties of the Forest Service. As a result of this classification non-agricultural lands are being held for permanent forest purposes and timbered lands are protected against fake entry. No special administration is provided for forest reserves.

No general reconnaissance of the forest is being undertaken Some work of an exploratory nature is in charge of the Forest Service. The Government has not yet interested itself in the comparatively large areas of timber under private ownership.

Forest fire-protection in Quebec except along railroads is practically confined to timber at present merchantable. The holders of timber licenses are required by law to patrol their holdings at their own expense: 514 men were so employed in 1913. The Government spends $24,000 a year on a general supervision of fire-protection. This amount is of course hopelessly inadequate. The public lands have suffered and still suffer terribly from fires. Fire-protection is under the control of a special branch of forest protection.

The more important license-holders have formed co-operative fire-protective associations, and are working out very effective plans for fire-protection, putting in trails, telephones, lookouts and protecting all timber under their jurisdiction.

Several large pulp and paper companies in Quebec are undertaking forest management on their holdings, making forest studies cutting with a view to a future crop, and making experimental stations.

The Provincial Government has started a nursery for the planting up of denuded non-agricultural lands. Small local plantations are being created including the non-agricultural portions of settled areas of the Province.

The forest revenue of Quebec for the year 1913 was $1,500,000. The expenditure on the forests was $122,000.

New Brunswick.—The total area of New Brunswick is 28,000 square miles of which 20,000 square miles is fit only for the production of timber. About one-third of the absolute forest lands have passed out of the hands of the Province in the form of railroad grants or lands taken up by purchasers and settlers.

The public timber lands are administered by the Crown Lands Department, the field staff consisting of a superintendent of scalers, chief lumber scaler and chief fire warden.

The principles followed in the administration of the remaining lands are much the same as in the Provinces already discussed. The exploitation of timber has, however, gone further. White pine once plentiful has been cut out and the lumber industry now depends on spruce. Practically the whole of the merchantable timber has been taken up by holders of perpetual licenses to cut which cover 10,147 square miles. 280,000,000 board feet of timber were cut from Crown lands in 1913. The rental per year for timber licenses is $8·00 per square mile. The royalty on timber varies from $1·00 per thousand for hemlock to $1·50 for spruce, pine, tamarach and cedar.

It is felt by the Government that the quantity of timber cut each year from public lands is in excess of the annual growth. No studies have been made, however, to determine this fact.

Though there is no systematic classification of lands for the purpose of creating permanent forests, the Government is evidently endeavouring to restrict settlement on alienation to agricultural

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There has been no forest survey or reconnaissance of the Province. A law has been enacted by the Legislative providing that such a survey shall be completed by 1917. It has not yet been begun.

The regulations under which the licenses to cut are issued require that all slash shall be lopped, that stumps be cut low, logs cut to a 5 inch limit in the tops and that no spruce or pine trees be cut which will not make a log sixteen feet long, nine inches in diameter at the top. This top diameter limit is reduced to seven inches for balsam. No supervision is provided beyond that of the scalers, of whom there are about 29 for the whole area of Crown lands, and who are responsible as well for all prevention of trespass and the scaling of timber.

The forest lands in private ownership are receiving no special care.

Fire-protection in New Brunswick is chiefly an auxiliary service dependent upon Government and local municipal officials whose duty it is to call out the population and extinguish fires or to arrest offenders. The Province appoints a chief fire warden with supervisory duties, but does not maintain a patrol force, nor does it require the holders of timber licenses to protect their timber or contribute towards its protection. The fire loss in the past has been very heavy. The sentiment of the people towards fire-protection is excellent.

The forest revenue of New Brunwick was $662,000. The expenditure on the forests was about $35,000, which is not sufficient to keep the forest areas of the Province in condition to provide the revenue now received.

Nova Scotia.—Nova Scotia is the one Province in Canada where the timber lands have all passed into the hands of private owners. The total area of the Province is 21,000 square miles, of which only a little over 4,000 square miles is suitable for other uses than the growing of timber. Only 2,200 square miles still belong to the Province. The timber in this area is leased at eighty cents per acre per year.

The Government, awake to the depletion of the forest resources, has had an exhaustive survey made of forest conditions. The survey shows at the most twenty years cut of timber still remaining on Government and private lands combined. The larger owners are skinning the land, the smaller owners are endeavouring to cut somewhat conservatively. The conditions in leases on public lands giving a minimum diameter limit of ten inches has no appreciable effect on the situation.

There are at present no regulations affecting logging on privately-owned land.

Fire-protection is left to municipal officers. There is no organisation maintained by the Government, nor any requirement of fire-protection affecting private timber owners. The sentiment of the people is good but the forest areas have suffered and still suffer very severely.

Legislative provision has been made for a Provincial Forester but none has been appointed.

British Columbia.—British Columbia is believed to contain over one-half the merchantable timber in Canada. The area of the Province is 355,000 square miles, of which 300,000 square miles is valuable chiefly for the production of timber.

Everything pertaining to the administration, protection and study of the forest lands of the Province is by the Provincial Forest Act placed in the care of the Forest Service. The head office organisation consists of the Chief Forester, responsible to the Minister of Lands and four Assistant Foresters, who have charge respectively of the offices of Management, Operation, Records and Reconnaissance. The office of Management is responsible for timber sales, land classification, forest studies, supervision of logging operations, timber scaling and markets. Operation includes fire-protection, grazing and personnel. The Records office, as its name implies, is the fiscal centre and takes charge of office affairs. The division of surveys has in charge the forest survey of the Province. These five officers are constituted, by legislation, the Provincial Forest Board, an administrative body having jurisdiction over all forest matters.

The Province for administrative purposes is divided into eleven forest districts each in charge of a District Forester. The Field staff in each forest district consists of forest assistants, permanent rangers, scalers and cruisers. The total permanent staff in the Province is about 150: a very small number for the amount of work to be transacted. The district foresters are selected from the forest assistants, rangers and other subordinate officers. The forest assistants are at present selected without an examination. As soon as candidates become more plentiful an examination test will be imposed. The rangers are selected from scalers, cruisers and forest guards. The rangers are required to pass examinations in scaling and cruising to secure permanent positions. Scalers and cruisers are required to pass examinations and field tests before securing appointments.

The various branches of work undertaken by the Provincial Forest Service can be discussed only briefly.

One of the first and most important duties was to ascertain the facts concerning the timber areas of the Province; twelve parties have been at work during the past three field seasons. The co-operation of the Dominion Commission of Conservation has been secured. It is expected that the work will be finished in a preliminary manner in another year. At the present time it can only be said that it appears that there is more timber of a merchantable size in British Columbia than has been usually credited to the Province. All timber is of course being estimated whether in private ownership or not.

The only method of securing the timber on any of the public lands in British Columbia is by purchase from the Forest Service. Before the creation of the Forest Service about 20,000 square miles of timber had been alienated. The amount of timber remaining on unalienated lands is as yet unknown, it is probably one-third of the total in the Province.

Up to the present the Forest Service has received application for 308 timber sales carrying about 400 million feet of timber. The areas applied for are cruised under the direction of the District Forester, by forest assistants or rangers. The principles are the

same as are followed in the United States Forest Service. An upset price is fixed upon each species depending upon its value in the tract examined, the timber is sold by public competition to the highest bidder. The timber sale contract which the purchasers must sign and for which he deposits a cash guarantee of fulfilment provides that a specified quantity of timber be removed each year, that the bush be handled according to the special clauses inserted for each sale and that fixed standards of utilisation be adhered to. The standards of utilisation are based upon the work of the best loggers in the district and are planned to reduce loss in stumps, tops, broken timber or scattered logs. The brush disposal is varied on each sale, the aim being to reduce the fire hazard and to encourage valuable reproduction. The greater part of the sales have been in types where clean cutting and broadcast brush burning have been satisfactory. Very few sales have been made in types where selection cutting was practised.

There has been in effect for nearly twenty years a law forbidding the alienation of public lands which averages over 8,000 feet of timber per acre West of the Cascades and over 5,000 feet per acre East of the Cascades. The object of this law is to retain for the public benefit the value of the timber on such land. The examination of public lands to prevent the evasion of this law by land purchasers and pre-emptors has been an important work of the Forest Service. Areas of public lands which are discovered to be timbered are reserved by the Lands Department and no alienations are made within the boundaries of such areas unless the applications are reported favourably by the Forest Service. The regions where timber lands are scattered and it is not feasible to declare the whole area under reserve the separate applications for pre-emptions are referred to the Forest Service for examination and action is taken on the recommendation of the service. This practice is working out to the great advantage of the Province by preventing fraudulent alienation of timber and by protecting *bona-fide* settlers from locating on lands upon which they would not be successful.

The administration of the 20,000 square miles of alienated timber referred to above is in the hands of the Forest Service.

Though this timber has been to a certain extent alienated the public still retains a great interest in it. The alienations are of three kinds: 6,000 square miles of Crown-granted or patented lands, 1,500 square miles of leased lands and 14,000 square miles of licensed lands.

In the greater portion of the Crown-granted lands the public retain a royalty interest in the timber amounting to fifty cents per thousand feet payable when the timber is cut. This royalty is collected by the Forest Service. These lands are also cruised to provide a basis of valuation for taxation purposes. The Forest Service now undertakes their work on behalf of other Government Branches. The Forest Service has no authority to regulate cutting operations on Crown-granted lands but has authority which has been exercised to require owners of Crown-granted land to remove at their own expense logging slash which constitutes a fire hazard.

Leased timber lands are subject to the control of the Forest Service, and though the leases were issued prior to the Forest Act, they are subject to the Forest Act or any of its amendments, or any regulations issued under the Forest Act. Licensed timber lands are similarly situated.

One of the chief duties of the Forest Service is the supervision of logging operations on licenses and leases. This supervision is directed towards the prevention of trespass on adjoining public lands, the collection of rental and royalty, the scaling of timber, the prevention of waste in logging and the disposal of logging slash.

All logging operations are inspected at frequent intervals by rangers and forest assistants. The number of operations is so great, 900 in normal times, that it is not economical to keep a man on each one. Cases of trespasses receive rigorous treatment. Operations are not allowed and property becomes forfeit if rentals and royalty are not paid. All timber cut or sold in the Province is scaled by employees of the Forest Branch and no other scale is legal. A staff of check scalers is maintained, acting under the district foresters, whose duty it is to supervise the work of the scalers and to form a final court of appeal.

The effects of the campaign against waste on logging and leaving brush to form a fire hazard is being felt slowly. During the three years the service has been in existence the lumber industry has been so demoralised that progress has been slow. It is not feasible in a democracy to enforce wholesale restrictive regulations when operators are losing money. The aim of the service in this respect is to gradually, by constant field inspection and the enforcement of simple regulations, raise the standard of logging to that set by the most progressive and careful operators.

The rental on timber licenses is so high, $140 per square mile per year West of the Cascades and $100 East of the Cascades that the logged overlands revert to the Government. It is a condition of the leases that the lands revert to the Government when the timber is removed. These logged overlands are examined by the Forest Service. The non-agricultural lands are held for forest purposes and the agricultural lands are opened for settlement.

The existing Legislation provides that the royalty on timber cut from leases and licenses shall be increased as the average wholesale price of lumber increases. The administration of this Legislation is a part of the work of the Provincial Service.

The present work of the service naturally suffers from lack of knowledge of forest conditions. As rapidly as the staff can be secured and trained research work and studies are being undertaken. This branch of the work has suffered and still suffers through the great volume of pressing administrative work which the staff must handle. As it is a start has been made upon reproduction studies, volume tables and a study of the habits and requirements of the various important species. Much will be learned from the timber sales already made. The service is still however very weak scientifically.

The great necessity of forestry in the West Coast is better markets. The Forest Service is now studying this question in co-operation with the lumbermen. It is hoped to add a Branch but this has been delayed by the war.

The Forest Service handles all fire-protection in the Province. All holders of alienated timber lands are required to pay one and a half cent (1½¢) per acre per year fire-tax. An equal sum, contributed by the Government, brings the Forest Protection Fund to about $340,000 per year.

Fire-protection is handled in the same manner as the administrative work, through the District Foresters. The District Foresters submit fire plans to the Head Office, stating how many five months' guards and how many two—three months' guards will be needed for the summer. They are given the necessary allotments and select, appoint, supervise and dismiss the men. The actual burden of this work falls on the rangers. The aim is continually to reduce the five months' guards in order to render more money available for the short term guards as the dangerous fire season in British Columbia rarely exceeds two months. No fires are allowed without permits during the five months' fire season. The Forest Act gives ample authority for dealing with all fire hazards. The duty of the guard is to patrol, issue and supervise burning permits, remove fire hazards, hire and handle fire fighting crews and prosecute offenders. The guard districts are very large from 50,000 acres up, therefore the District Forester is empowered to appoint extra patrol men in dangerous districts as need arises.

The Forest Service fights fires no matter where they occur on alienated lands, public lands, mature timber or reproduction. Where private owners are responsible the cost is later collected from them. Whenever the fire season leaves any money in the Fire Protection Fund permanent improvements are constructed. Some 1,500 miles of trail, 500 miles of telephone and 30 petrol launches and several ranger cabins are now completed.

Nearly 500 men were on guard duty in 1914. The advanced settlement of the Province is spreading the area of the fire hazard very rapidly. It will soon be almost impossible to protect large northern areas. Fortunately the sentiment of the public is excellent. Forty prosecutions in 1914 added to the respect for fire-protection. Over 3,000 fires occurred. The loss was 70,000,000 feet of timber, chiefly inaccessible at present.

No actual provincial forests or forest reserves have been set aside as yet, the whole Province is under the same administration as the Forest Service could give any special segregated areas. As settlement increases forest reserves will undoubtedly be created. Legislative provision for this now exists.

Grazing on public lands is now being investigated by the Forest Service in order that a system of administration may be worked out. The Province possesses valuable grazing resources which are at present utilised. It is planned to administer these on a permit and leasing system in such a manner as to encourage their wise development.

The forest revenue for British Columbia in 1913 was about $3,000,000. The expenditure for the same year was about $530,000. The revenue will increase as the timber industry increases. There is every hope that the policy of forest administration recently adopted by the Government will result in the forest lands of the Province being made annually more productive.

Canada has not yet travelled far along the road which she must travel if she is to make the most of her possibilities. That she has started along the road is due largely to the aggressive educational campaign carried on by American foresters, a campaign which has spread far beyond the boundaries of the United States and produced profound effects on other countries, and to the friendly spirit of co-operation shown by American foresters, who have time and again placed their services generously at the disposal of Canadians.

ORENSTEIN AND KOPPEL'S LIGHT RAILWAY MATERIAL.

As will be seen from our advertisement columns, the business of the above firm is being liquidated by Messrs. Parry & Co., and has been closed down. This latter firm is undertaking the manufacture of new material and arranging to supply material similar to that previously supplied by Messrs. Orenstein and Koppel of British manufacture. We draw attention to this in the interests of those who may have considered themselves likely to be inconvenienced by the closing down of the firm of Orenstein and Koppel.

notes and show how each has done his bit on behalf of the Empire.

EXTRACTS.

PENSIONS OF OFFICIALS WHOSE SERVICES ARE PARTLY INFERIOR, PARTLY SUPERIOR.

The following correspondence has been sent us for publication :—

Despatch from the Government of India to the Secretary of State.

We have the honour to invite a reference to your Lordship's despatch No. 32 (Financial), dated the 13th March 1914, in which sanction was conveyed to the proposal to class as superior the service of such grades of forest guards, on pay exceeding Rs. 10 a month, as might be specified by the Local Governments and Administrations concerned, to whose discretion it was left to bring the change into force when they considered it desirable to do so.

2. Our intention was that a forest guard on pay exceeding Rs. 10 a month should count all past service for pension on the superior scale ; but the Government of the United Provinces, a copy of whose letter No. 633, dated the 20th August 1914, and its enclosure is submitted for your Lordship's information, points out that in framing our proposal we did not specifically ask for exemption from Article 398 of the Civil Service Regulations, under which an officer promoted from inferior to superior service rarely becomes eligible for pension equivalent to half his pay. In consequence, a forest guard drawing over Rs. 10 a month and officers of

higher rank with several years of inferior service may often derive little benefit from the concession now accorded to them. We therefore request that your Lordship may be pleased to waive the provisions of Article 398, Civil Service Regulations, in favour of officers who begin service as forest guards on the inferior scale and subsequently rise to appointments in superior service in or above the rank of forest guard.

To the above the following reply was received :—

* * * * *

3. Having considered in Council your letter of the 25th December, No. 474, I sanction your proposal to waive the provisions of Article 398 of the Civil Service Regulations in favour of officers who begin service as forest guards on the inferior scale and subsequently rise to appointments in superior service in or above the rank of forest guard. In sanctioning the proposal contained in your letter of 30th January 1914, No. 28, I understood your recommendation, in virtue of the remarks contained in the first paragraph, to imply that a forest guard on pay exceeding Rs. 10 a month should count all past service for pension on the superior scale.

EFFECT OF GRASS ON TREES.

This subject was brought into prominence a few years ago by the researches of S. U. Pickering, of the Woburn Experimental Fruit Farm, in England. We have previously noted in these columns his observations concerning the very injurious influences of grass on orchard trees, apparently due to some toxic substance produced by the former. The question has now been taken up at another English research institution, *viz.*, the Long Ashton station of the University of Bristol. Mr. Barker also finds that grass seriously impairs tree growth, but the effect is less marked in land which is grassed at the time the trees are planted and remains so than in land which is first cultivated and subsequently grasses. In other words, trees are able to acquire some degree of immunity from the toxic effect in question.—[*Scientific American.*]

A VALUABLE SUB-TROPICAL HAY GRASS.

At the Third International Congress of Tropical Agriculture attention was called to a valuable species of grass that has been introduced into South Africa with remarkable success. This is known as Teff (*Eragsostis abassinica*) and is an annual hay grass, particularly suitable as a summer catch-crop, and a smother-crop for weeds, owing to its rapid growth when weather conditions are at all favourable. It gives a heavy yield of hay of fine quality and high nutritive value, more nearly resembling English meadow hay than any other hay grass grown in South Africa. If sown with the early spring rains it has been possible to cut three crops of hay in the season, giving 2½ to 3 tons per acre, and to obtain autumn grazing from the aftermath. The introduction of Teff grass into South Africa has raised many small farmers struggling for a living to positions of comparative comfort and independence. They are unanimously agreed that this introduction alone has repaid over and over again the whole cost of the Division of Botany of the Department of Agriculture from its inception to date.—[*Scientific American.*]

PREVENTING SOIL EROSION.

Soil erosion is doing immense damage constantly and few people know how to apply preventive measures. In the annual report of the Bureau of Soils of the Department of Agriculture a simple method of handling one class of erosions is described. This is the case where the soil is being washed away in gullies, and the remedy is to build a dam across the incipient gulley through which a sewer pipe is passed, connecting with an upright pipe situated at the upper side of the dam. The hollow formed by the dam will fill with water in flood conditions until the top of the upright pipe is reached, when the excess of water runs off quietly into the next field or into another impounding space below. The cutting current of the draining water is stopped and the sediment carried by it settles above the dam, thus tending to repair the

damage previously done. A suitable tile drain located under the dam will dispose of the water impounded below the opening of the upright pipe.—[*Scientific American.*]

TREES THAT WEEP.

(From a lecture delivered by Dr. David Hooper, F.C.S., F.I.C., F.L.S., at a meeting of the Pharmaceutical Society of Great Britain, London, on 9th March 1915.)

Dr. Hooper said that the British Pharmacopœia enumerates twenty drugs which are described as tears, or are the natural exudations of plants. The leaves of a nasturtium, under certain conditions of climate, exude drops of water which are not to be confounded with dew. The one is the result of transpiration in the plant, the other is condensed from atmospheric moisture. A small instrument made of a bent glass tube illustrates that force in plants which causes the exudation of juices; the force is known to botanists as "root pressure." This phenomenon is exhibited in a remarkable manner by the drawing of "toddy" from the cocoa-nut palm and other palms in British India, the juice being largely used in making sugar and alcohol.

The natural exudations of plants may be classified as soluble and insoluble gums, kinos, gum-resins, oleo-resins, oleo-gum-resins, balsams, lacquer, opium, hemp, caoutchouc, mannas, and mineral concretions. Nature, therefore, produces tears which may be mucilaginous, astringent, pigmental, resinous, odoriferous, soapy, medicinal, elastic, saccharine, acid, salt, and petrified. Photographs of Western Asia and India illustrate the regions where the more valuable exudations are collected.

Regarding the formation of gum arabic, enlarged tears observed *in situ* show that they proceed from injured portions of the bark. A section of the stem indicates the gummy layer on the outer part of the liber, and a more magnified view of the gum cells shows their gradual disintegration brought about by chemical change. Tragacanth, a type of insoluble gum, is formed from the cellulose of woody tissue. Astringent gums of the kino order

are yielded by species of Butea, Pterocarpus, and Eucalyptus; some varieties are more soluble than others in water and alcohol, and in India the Malabar kino is superior to that of Bengal.

The Trigona or Melipona is a small stingless bee of Burma that constructs its nests of resin or dammar collected from the forests; the oleo-resin of Dipterocarpus or Gurjan-oil tree is largely employed for this purpose. The resinous mixture forming the nest, called "Pwenyet," is a commercial article of some importance, and is chiefly used for caulking boats.

Modern methods of tapping trees for resin and turpentine have for their object a maximum yield of produce with a minimum amount of damage to the tree; very few turpentine trees are now killed by overtapping. The longitudinal arrangement of laticiferous vessels in the bark of trees is the reason for more or less transverse incisions being the order in all systems of tapping. The method adopted for tapping dammar, gamboge, lacquer, and india-rubber all partake of this character. The collection and trade in myrrh, incense gums, and Balm of Gilead around the coasts of Arabia are very ancient industries, and the emporium of the traffic is Bombay. The official balsams of Peru, tolu, benzoin and storax yield benzoic and cinnamic acids well-known for their germicidal nature, and the value of their use in early days is confirmed by modern discoveries in antiseptic medicine.

The opium poppy and Indian hemp are two narcotic drugs of the East, the active principles of which exude in the form of tears. The present trouble with Turkey may open the way for the use of Indian opium in new markets in the West. Indian hemp occurs in the manufactured forms as 'bhang,' 'ganja,' and 'charas,' containing respectively 10, 20 and 40 per cent. of oleo-resinous secretion; female plants afford most resin.

Lacquer is a natural varnish exuding from species of Rhus and Melanorrhœa; it is used for protecting wood from insects, and in many ornamental and artistic industries in Burma, China, and Japan. The cultivation of rubber has been very extensive within the last few years, while Para rubber (*Hevea*) is the most successful Ceara rubber (*Manihot*) and red rubber (*Ficus elastica*) are

imported in some quantity from the colonies. The occurrence of the peculiar saccharine secretion called 'manna' is a remarkable feature of vegetable life. The manna ash of Sicily is the most typical tree of this kind; the tamarisk, willow, olive, and rhododendron occasionally yield a sweet exudation. Tamarisk bushes give a manna even in the most dry and sandy situations and the common bamboo has been known to produce sugar in times of famine in the driest season in India.

Insects are frequent agents in causing trees to weep. The well-known tears of resin on stick-lac are caused by exudations from bodies of the female lac-insect living on the branches of trees The Rain tree (*Pithecolobium*) of South America, received its name because of insects residing in the leaves and branches secreting a liquid which fell on the ground like rain. The ghost bug (*Phromnia marginella*) inhabits the lower ranges of the Himalayas, and lives on *Elæodendron glaucum*, and other trees of the Celastrus order. It is in the habit of depositing a liquid on the tree which dries and becomes as white as snow. This was first regarded as a wax, but chemical examination shows it to be dulcitol, an isomer of mannitol. Other secretions of trees of some interest are the acid liquid of the chick pea (*Cicer arietinum*), the salt exudation on species of Salsola, and the mineral or lime concretion of the teak (*Tectona grandis*).—[*The Pharmaceutical Journal and Pharmacist.*]

WOOD OF 200,000 YEARS AGO.

REMARKABLE SPECIMEN.

There is at La Brae, near Los Angeles, Cal., a spot of extraordinary scientific value, writes F. Maxwell in the *Scientific American*. It is an asphalt deposit from which bones of prehistoric animals have been taken by the ton, among them the skeleton of a man supposed to be 200,000 years old. The asphalt pit was apparently once a fissure filled with viscid oil or magna. Animals that ventured upon it sank and perished. The place is full of

bones, skeletons of camels, sloths, tigers, wolves, bisons. It is believed that most of these animals belonged in the Pleistocene period, immediately preceding the modern, and that they lived some 200,000 years ago.

A log of wood, with bark still on it, was found standing upright among the bones. How it happened to reach that place and attain that posture is a matter for speculation. The bark is rough and stringy, but falls to shreds when the asphalt is dissolved out with gasoline. The wood is quite dark. The colour does not seem to be due to the asphalt, because when a gramme of chips is soaked in a few cubic centimetres of gasoline for a day or so little colour is imparted to the liquid. Neither does the wood respond to tests for tannin. Although brittle and hard to cut in thin cross sections, the wood does not differ materially in hardness from other soft woods.

The tree was of very slow growth. Each annual ring is about three-tenths of a millimetre broad, and there are from eleven to fifteen rows of wood cells to the ring. The resin ducts may be plainly seen with globules of resin in them. The state of the wood's preservation is wonderful. The delicate cells, even down to their bordered pits and tori, are all in place and unbroken, though apparently slightly compressed. Under the microscope the wood looks as fresh as a sample newly cut from a living tree, except that the grains of starch or other substance in the medullary rays are slightly shrivelled, and threads of fungus are visible. The wood appears to be one of the junipers.

The tree was evidently dead before it went into the asphalt. The presence of the fungus is the proof of this. There are many fine threads, or mycelia, not more than twelve ten-thousandths of a millimetre in diameter, ramifying through the wood, lengthwise with the wood cells, and also penetrating their lateral walls. Some of these threads are a centimetre long. The position of the fungus indicates that its activities were suddenly ended. That doubtless occurred when air was excluded by the log's immersion in the plastic asphalt. Everything remains as it was at the last minute. Many of the mycelium tips appear just in the act of piercing a cell

wall. Here and there are branches just budding from a main thread. It reminds one of the fate of Pompeii—the suddenness with which life was blotted out. Substitute a colony of fungus in a log of wood for a city full of men ; a pool of oil for hot ashes ; and the similitude is complete.

Oil is evidently an excellent preservative. During two thousand centuries that tree lay buried in the asphalt, and it comes out as well preserved as it was the day it went in. The wood's examination was made with a power of 300 diameters on an ordinary microscope. The wood sections were cut from points within two centimetres of the bark.—[*The Timber Trades Journal.*]

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SANDALWOOD.

By C. C. Wilson, I.F.S.

(*a*) A Parasite.
(*b*) Susceptibility to fire.
(*c*) Damage by borers.
(*d*) Spike disease.

In the *Indian Forester* of the years 1903, 1904, and 1905, Sandalwood, its method of growth, and its peculiar susceptibility to fire and other injurious influences were largely discussed.

(*a*) Its parasitic habit of growth excited considerable interest, and this was even called in question by some authorities, though afterwards verified beyond dispute. In South India various preliminary working-plans have been drawn up for the treatment of this valuable species and in nearly all these working-plans a most extensive list of "associates" has been given. These "associates" do not pretend to be any more than what is implied by the name, that is to say, species which are found associated with sandal. It remains to be proved whether or not all these associates may be selected to act as hosts by the parasite or not.

I have been engaged during the past 18 months in preparing more elaborate working-plans for this species in the forests of South Vellore, North Salem and South Salem, and in the course of my work have been in a position to examine the roots of a large number of associates, and the following statement gives a list of trees on the roots of which I have personally seen the sandalwood parasitic. I have in two cases found the *haustoria* (with the sandal rootlet attached) on the *bark* of the *main stem* of the host, just below the surface of the soil. In these two cases the hosts were a well-grown *Acacia leucophlœa* of about 30" girth at 4' from the ground, and a smaller *Melia Azadirachta* about 20" in girth. In both cases the sandalwood was especially well grown and healthy :—

Natural Order.	Associates of Sandal.	
	Botanical name.	Vernacular name.
	Trees.	
Leguminosæ ...	1. *Albizzia odoratissima* ...	Vagai and Solai.
	2. ,, *amara* ...	Turingi and Usil.
	3. *Acacia leucophlœa* ...	Velvaylam.
	4. *Dalbergia latifolia* ...	Iruvadi.
	5. *Pongamia glabra* ...	Pungam.
	6. *Butea frondosa* ...	Murukan.
Rutaceæ ...	7. *Feronia Elephantum* ...	Vela.
Burseraceæ ...	8. *Protium caudatum* ...	Pachai Kiluvai.
Meliaceæ ...	9. *Melia Azadirachta* ...	Veppam and Vembu.
	10. *Chloroxylon Swietenia* ...	Porasu.
Combretaceæ ...	11. *Anogeissus latifolia* ...	Nammai.
Melastomaceæ ...	12. *Memecylon edule* ...	Allimaram.
Rubiaceæ ...	13. *Canthium didymum* ...	Nekkini.
Ebenaceæ ...	14. *Diospyros Chloroxylon* ...	Karuvakknai.

Natural Order.	Associates of sandal. Botanical name.	Vernacular name.
	TREES—(*contd.*).	
Apocynaceæ ...	15. *Wrightia tomentosa* ...	Palai.
Verbenaceæ ...	16. *Premna tomentosa* ...	Podunganari.
	17. *Vitex altissima* ...	Mailadi.
Lineæ ...	18. *Erythroxylon monogynum*	Sembulichan.
	SHRUBS AND CREEPERS.	
Leguminosæ ...	19. *Acacia Intsia* ...	Seengai.
	20. *Acacia pennata* ...	
	21. *Pterolobium indicum* ...	Kar indu.
Rhamneæ ...	22. *Zizyphus Œnoplia* ...	Surai.
	23. *Scutia indica* ...	
Rutaceæ ...	24. *Atalantia monophylla* ...	Kat elimichan.
	25. *Limonia acidissima* ...	Nay vela.
	26. *Toddalia aculeata* ...	
Sapindaceæ ...	27. *Dodonæa viscosa* ...	Virali.
Rubiaceæ ...	28. *Webera corymbosa* ...	Terani.
	29. *Randia dumetorum* ...	Karai.
	30. *Ixora parviflora* ...	
Euphorbiaceæ ...	31. *Flueggea Leucopyrus* ...	Veppula.
Oleaceæ ...	32. *Jasminum* sp. (*auriculatum*).	Kattu mulligai.
Cacteæ ...	33. *Opuntia Dillenii* (prickly pear).	Sappathi Kalli, Nagathali.
Verbenaceæ ...	34. *Lantana aculeata* ...	
Gramineæ ...	35. *Bambusa arundinacea* ...	Mungil, Peruvarai.
	36. *Dendrocalamus strictus* ...	Mungil, Siruvarai.

(*b*) The fact that sandal is peculiarly susceptible to damage by fire has been long established. The reason for this is not so

clear, but I would advance the theory that this is the case owing to the fact that the delicate *haustoria* by which the rootlets of the sandal extract nourishment from the host, and which are nearly always within a few inches of the surface of the soil, are destroyed by the heat, which would not be sufficient to kill the rootlets themselves.

(*c*) The borers that Stebbing mentions as attacking sandal are *Zeuzera coffeæ*, *Sirex* sp., and *Stromatium* sp. The last mentioned he afterwards states to be *Cœlosterna* sp., he is unable however to be sure of it as he has only succeeded in finding the larvæ. I found larvæ, exactly corresponding with Stebbing's description, boring in sandal in the Javadis, and succeeded in breeding out one imago. Whether this is the same insect as that found by Stebbing I am not, however, in a position to say, though as already stated its appearance corresponded with the description he gives.

The grub, boring in the heartwood of a branch of a sandal tree, was found on November 16th, 1913. The branch was placed in a tin box and taken to Vellore. Here it was looked at at the beginning of February, March, April and May. On the last occasion the imago was found to have hatched out. This was a slim longicorn beetle about ½" long by rather more than ⅛" broad across elytra and thorax. Elytra, thorax and head were a reddish brown, and the mouth parts black; the abdomen was blackish grey with five segments; the antennæ were black on top, greyish below and much longer than the body; they consisted of 5 large segments followed by 5 smaller ones, the latter being greyish in colour. At the end of the 2nd, 3rd, 4th and 5th segments was a conspicuous tuft of black hairs. This beetle I sent to the Forest Research Institute at Dehra Dun, where it was identified as one of the *Lamiidæ*, sp. unknown, and not a *Stromatium* or a *Cœlosterna*.

The grub was found boring in the heartwood of dead and dying branches of otherwise healthy saplings and many trees in a single locality were attacked. It appears, therefore, that this insect would be capable of doing considerable damage if it were to increase to any great extent.

(*d*) The problem as to the cause of spike disease in sandal does not seem to have approached any nearer a solution in the past few years. It seems to be accepted as an established fact that when an area is badly attacked by this disease the sandalwood completely dies out; this means a permanent loss of lakhs of rupees of revenue per annum to the State; and yet nothing is done. Surely it is time that some officer was specially detailed to study this extremely destructive disease for as long a period as is necessary to discover its origin, and, if possible, its cure.

THE MONOPOLY AND ROYALTY SYSTEM OF SALE, AND ITS APPLICATION IN THE RAMNAGAR FOREST DIVISION, U. P.

BY S. D. RANADE, ASSTT. TO THE SYLVICULTURIST.

The Sal forests of the Ramnagar Division are at present being worked under the Selection *cum* Improvement fellings system, with a view to take out, under the selection part, mature and overmature trees that were left standing in the former workings, and under the improvement fellings, to improve the growing stock, by favoring the growth of the more promising stems of the future, by the elimination of badly-grown stems and stems of the inferior species, interfering or likely soon to interfere with those of the more valuable species.

In the markings which are carried out in the year before the fellings, apart from cultural requirements, public demand has to be taken into consideration, and only trees that are marketable are marked for the principal fellings. Departmental cleanings, which are of immense importance in these forests considering their consistence and composition, have, therefore, to be carried out in the coupe the year after the fellings.

The trees marked in the forest are disposed of by public auction, and except in one solitary instance, in which the sale was effected by the Lump Sum system, the trees were sold to contractors under the Monopoly *cum* Royalty system of sale.

The Lump Sum system of sale is of primitive simplicity, and consists of nothing more nor less than that the contractor, by paying a certain amount of money, obtains the exclusive right to extract as much of the marked standing timber, as he can or as much as he wishes to, the timber, etc., extracted not being subjected to any further payments.

This system of sale has its own advantages and disadvantages, but it is with the other system of sale that we have to deal here.

Stated broadly, the Monopoly *cum* Royalty system of sale means that the purchaser by paying a certain sum of money obtains the monopoly to extract timber, etc., from the area under auction, the amount of money thus paid being called the Monopoly price. In addition to this monopoly price, the purchaser has to pay "Royalty" on all timber, etc., extracted from the forests, whether in the round or after conversion. For this purpose a table of Royalty rates is made out laying down the rates for all varieties and sizes of timber, these rates being generally equal to about half the value of the material.

We shall now trace, step by step, the working of this system in the Ramnagar Division.

The Marking officer does the markings in the coupe of the following year. The Enumeration register kept up by this officer is in an elaborate form and among other things shows the estimated volume of the timber yield in the sound Sal and Sain trees of the 1st and 2nd classes. The valuable trees are numbered in different series, among which those for the sound Sal and Sain deserve special mention.

After the markings, the register or its extract is sent to the Divisional Officer, where the total estimated volume of Sal and Sain timber is made out, while volume figures for the other varieties of timber, etc., are estimated from previous records. These figures give an idea of the probable total yield of the coupe, which facilitates the fixing of an upset price for the monopoly.

The coupe, if too large, is divided into a number of small lots, and sold separately, thus giving petty contractors a chance to purchase.

The auction is advertised far and wide, and the would-be purchasers from different places (chiefly from Delhi) attend the auction which is held in the rains.

A description of the produce, the conditions of sale, working and extraction, and the Royalty rates are then read out to the would-be purchasers. The Divisional Forest Officer also guarantees the purchaser that if the coupe fails to yield a certain minimum amount of timber, etc., a proportionate amount of the Monopoly price will be refunded. Such a case has not, however, as yet occurred.

One of the conditions of sale provides that the coupe will not necessarily be sold to the highest bidder, while another empowers the Divisional Forest Officer to stop the auction at any stage, should he think it desirable. The reasons for these conditions are obvious : the first provides against the coupe being sold to a man of uncertain standing and doubtful solvency ; while the second is effective in preventing the formation of a "purchasers' league" (which has been known to occur), by which the would-be purchasers bind themselves not to outbid each other. A third condition lays down that each purchaser will, on conclusion of the sale, deposit a certain percentage of the price as Security Money.

The auction then proceeds.

After a lot has been sold, the purchaser pays in the security money, and signs the sale contract deeds. These deeds, among other things, prescribe the manner in which the Monopoly price is to be paid, and they also lay down the modes of felling and the routes of extraction.

It must be here noted that, before actual extraction is begun, the contractor has to deposit in the Treasury, to the credit of the Divisional Forest Officer, as an advance payment, a sum of money to meet part or all the Royalty charges on the produce that he will subsequently remove. These advance payments are transferred from the deposit to the revenue account of the Divisional Forest Officer, progressively, as the produce is extracted. If the deposit is running short, the contractor, in order to avoid his export being stopped, has to pay into the treasury a further advance. This

procedure is of immense importance, as it obviates the necessity of paying the money into the hands of the "Export Jemadars" (who are, after all, only temporary officers). Export on credit is forbidden.

The commencement of felling operations brings us to the first Government official directly connected with the fellings. This is the "Stump Moharrir."

The "Stump Moharrir" is an official on the temporary establishment drawing between Rs. 10 and Rs. 20 per mensem. He is directly in charge of the fellings, and his duties are—

(i) to see that only the marked trees are cut;

(ii) to serially number the stumps of the trees, as they are felled, with coal-tar;

(iii) to maintain a register which records the number, species, girth, soundness or otherwise and outturn of timber in cubit feet of the trees felled;

(iv) to submit, for the information of the Divisional Forest Officer, weekly reports of the working together with extracts from the register maintained under (iii) above.

The expenditure entailed by the appointment of these Moharrirs is justified in that—

(*a*) the serial numbering is a check upon illicit felling;

(*b*) the outturn registers furnish valuable information for future reference for estimating the approximate yield of a similar coupe, and to a large extent prevent the possibility of the contractors smuggling the timber with a view to avoiding the payment of Royalty, since the outturn figures can always be compared with the volume of timber that has actually passed through the "Export Chowkies"; and

(*c*) the weekly reports keep the Divisional Officer informed of the progress of the work.

Having felled the trees and converted them into timber of dimensions commonly in demand, (which is generally done in the forest to minimise the cost of transport,) the contractor extracts

the timber in carts or on dragging animals, by the prescribed routes. The timber ultimately comes to the "Export Chowki."

The Government official in charge of the Chowki is called the "Export Jemadar." The contractor also keeps one of his clerks at this Depôt to satisfy himself that the Royalty is being correctly charged.

The "Export Jemadar" maintains a register in Range Form V (copy attached for reference), a separate book being kept for each lot sold.

As soon as the timber is brought to the Chowki, the "Export Jemadar" measures the different pieces with a tape, finds out their volume from a Ready Reckoner, and charges Royalty on the same according to the fixed rates list, a copy of which is provided him. He fills in the Range Form V, preparing it in triplicate, signs it and obtains the signature of the contractor's agent thereto. He then marks the timber with his hammer in order to show that Royalty has been paid on it. He keeps one copy of the Form V with himself and gives the other two to the cartmen, who now proceed to the Check Chowki with the timber. It should be noted that as soon as a purchaser pays into the treasury the deposit referred to in para. 13 above, the treasury chalan is sent to the "Export Jemadar" for his information. He thus knows the amount to the credit of each contractor, and keeps a running account for each. If the deposit account runs out, the Jemadar stops the timber at the Chowki, until a further payment has been made into the treasury.

The timber is now taken to the "Check Chowki." This Chowki is in charge of the "Check Jemadar."

On the arrival of the timber, the Jemadar takes from the cartmen the two copies of Form V given to him by the "Export Jemadar." He checks the measurements and the Royalty charged and then signs the form, one copy of which is given back to the cartmen and the other retained by him. The object of giving a copy to the cartmen is to prevent any interference with him on the part of forest or police officials. He then marks the timber with his own hammer in token of satisfaction. The timber has

now passed through all the checks and may be taken wherever the contractor wants it.

If the "Check Jemadar" finds any mistakes of a minor character, *e.g.*, mistakes in measurements or in the amounts of Royalty charged, he simply corrects them in the forms and communicates the same to the "Export Jemadar" who corrects his registers. But if he finds any mistakes of a serious nature, *e.g.*, a piece of timber not marked by the "Export Jemadar" (on which Royalty has apparently not been paid), he seizes it and then reports the fact to the Divisional Officer. Or if he finds that the timber is marked by the "Export Jemadar" although the Deposit account of the contractor has run out, he stops it and reports the fact.

The "Check Jemadar" maintains registers, one for each contractor, in which he embodies the information in Form V which he collects from the cartmen, and he submits weekly statements supported by copies of these to the Divisional Officer who is thus kept informed of the amount of timber, etc., extracted week by week.

Having traced, so far, step by step, the working of the system in the Ramnagar Division, a few words on the advantages of the system are added, as also its drawbacks:—

Firstly, the Divisional Forest Officer's guarantee referred to above, induces the purchasers to offer fair prices at the sales, though it should be noted that this guarantee is not an essential part of the system, and is merely given to safeguard the contractor from loss and reassure them.

Again under this system, the contractor endeavours to remove the maximum amount of timber, since he has paid the Monopoly price which represents a considerable portion of the value of the timber in his area.

Lastly, the Department obtains, as a rule, fair price.

The principal disadvantages of the system are—

(i) The Department has to incur considerable expenditure in maintaining the Export and Check Chowkies,

(ii) This system is not always suitable to localities traversed by a large number of roads, as these would render supervision complex and difficult.

(iii) That very careful and constant supervision over the various Moharrirs is required to prevent collusion and attempt at fraud on the part of low paid men.

Once such supervision is relaxed opportunities for fraud will occur. It is, however, to the credit of the various Range Officers and of the Moharrirs themselves that instances of fraudulent extraction are rare.

In conclusion, the Monopoly *cum* Royalty system is somewhat elaborate, but under it, safeguards exist for our Indian contractors, while the Department obtains fair value. The system has been successfully employed in the Ramnagar and other Divisions for a number of years, and its retention proves that it has been found satisfactory; its introduction might well be tried in other places where low prices at the auctions are generally the rule.

Range Form V.

Division........................ Range...................... ..

Working Circle.............. Compartment No.......... Date.........

Name of purchaser..................

Description of produce.	No. of pieces.	Dimensions.	Cubic contents.	Rate.	Amount of Royalty.	Carter's name and Remarks.

Total ...	....
Previous balance ...	....
Balance to credit ...	....

Purchaser's agent.........................

Check Jemadar.........................

Date of checking.........................

....

Export Jemadar.

KEY TO FOREST FLORA OF THE SOUTHERN CIRCLE, CENTRAL PROVINCES.

BY H. H. HAINES, I.C.S.

In continuation of the List of the Trees, Shrubs and Herbs of the Southern Circle, which has recently appeared in the *Indian Forester*, the following artificial key is published. The key is based almost entirely on vegetative characters, such as can be ascertained with the unaided eye or, at most, with the occasional use of an ordinary pocket lens magnifying up to 10 diameters. Artificial keys to be of any use must be exhaustive, that is, they assume that all the species to be found in the area are included in the key. For this reason no key has been given to the herbs and, in dealing with the herbaceous climbers and undershrubs, users of the key should be on their guard against finally naming the species by the key, as all herbaceous undershrubs and climbers are not included in the list. In the case of the indigenous trees and shrubs, however, it is hoped that the list is very nearly complete. Owing to the great variability of vegetative organs their changes with locality and the age of the individual, and the frequent difficulty in describing their characters in concise terms, keys based on them are less satisfactory than those based on the reproductive organs. On the other hand, there seems to be a general opinion that their use demands an even slighter knowledge of Botany than is the case with keys based on the flowers and fruits. The key is divided into five main headings and the explanations of all headings, where not self-explanatory, are given in the text.

In cases of doubt as to which category a plant belongs it will be found in *each* category to which it is capable of belonging. Two columns of numbers precede the names of the species (or genus where only one species of the genus is described). The numbers contained in the first column are serial and are used for cross references within the key itself. The numbers contained in the second column refer to the position of the plant within the list itself. Where the number of secondary nerves is given this signifies the number on one side of the midrib only. The word

pairs is omitted. I find, from users of the Chota Nagpur Flora, that the use of the word 'pairs' is liable to misunderstanding except as meaning that the members are opposite to one another, which was not there intended. In describing pinnate leaves, therefore, the word pairs is now only used where the leaflets are opposite. In cases where the leaflets are not opposite the total number of leaflets is given.

The following abbreviations are used :—

1—2", one to two inches in length or, in the case of a flower, one to two inches in *diameter*.

Fl.	... ...	Flower.
Fr.	... ...	Fruit.
L.	... ...	Leaves.
ell.	... ...	elliptic.
lanc.	... ...	lanceolate.
m. s.	... ...	moderate-sized.
peti.	... ...	petiole.
sec. n.	... ...	secondary nerves.

ARTIFICIAL KEY TO THE TREES, SHRUBS, CLIMBERS AND UNDERSHRUBS.

PART I.—TREES.

Plants with distinctly woody stems and *branches*, attaining 15 ft. and more in height, excluding Palms and Bamboos (q.v.).

I. Leaves simple [includes also leaves with only 1 leaflet and deeply lobed leaves in which the lobes are connected at the base]. (See also 197 which sometimes has 1-foliolate leaves.)

A. Leaves opposite or whorled (sub-opposite only in some Terminalias and Anogeissus ; sometimes alternate at the ends of quickly growing shoots ; often fascicled in Nos. 11—15).

§ Margins of the leaves quite entire.

* Leaves penni-nerved (*i. e.*, with only one strong nerve, the midrib, starting from near the top of the petiole. Nerves starting from the midrib are called secondary. If these consist of strong and finer intermediary nerves, only the stronger are

counted as secondary. Nerves starting from the secondary are termed tertiary.)

† Juice milky (Apocynaceæ exc. 5).

(1) Large tree. L. whorled with many spreading very fine sec. n.	1	331	Alstonia scholaris.
(2) Small trees. L. bi-farious. Branchlets solid.			
(a) Milk yellowish. L. 3—5" tomentose.	2	334	Wrightia tomentosa.
(b) Milk white. L. 6—12" glabrous or pubescent.			
Leaves more or less oblong, usually narrower below middle. Fls. with linear scales. Follicles cohering at their tips.	3	333	Wrightia tinctoria.
L. more or less ovate, usually broader below the middle. Fls. without scales. Follicles divergent.	4	332	Holarrhena.
(3) Small tree. Branchlets hollow. L. large hispid.	5	477	Ficus hispida.

†† Juice not milky.

(1) Large trees (exc. 6) with deciduous stipules, youngest pair covering the prominent bud and leaving a marked interpetiolar scar on falling (Rubiaceæ exc. 6).

(a) Terminal buds lanceolate, ·5—·75" long. L. longer than broad.

L. shining coriaceous. Sec. n. over 14 each side. Fls. in axillary cymes.	6	259	Carallia.
L. not coriaceous. Sec. n. under 14. Branchlets often terminating in a globose head of flowers or a succulent pseudocarp.	7	293	Anthocephalus.

(*b*) Terminal buds very broad or oblong, blunt.

Buds sub-orbicular. L. cordate. Fls. in globose heads.	8	291	Adina.
Buds oblong. L. broadly elliptic. Fls. in globose heads.	9	292	Mitragyna.
Buds oblong or branchlets terminating in tomentose panicles of small fls. or recurved capsules. L. 4—10″ ell., pubescent.	10	294	Hymenodictyon.

(2) Small trees. Stipules interpetiolar, deciduous or not, buds gummy or inconspicuous (Rubiaceæ).

(*a*) Branches spinescent. L. mostly fascicled.

Bushy. Thorns close 4-seriate. L. ·5—3″. Fls. small yellowish. Fr. small ·7″.	11	303	Canthium parviflorum.
Bushy. Thorns sometimes few. L. 3—4″ (small at time of fl.). Fls. small green. Fr. 1—1·5″.	12	205	Vangueria.
Bushy. Bark brown. L. 2—4″. Fls. m. s. white ·5—1·5″. Fr. m. s. 1—1·25″.	13	302	Randia dumetorum.
Straight or bushy. Bark black. L. 2—8″. Fls. large white 1·5—2.″ Fr. large 2—2·5″.	14	301	Randia uliginosa.
Straight. Bark white. L. 1—4″. Fls. m. s. white, usually when leafless. Fr. large 2—3″ hard.	15	300	Gardenia turgida.

(*b*) Unarmed (see also 14 which is sometimes unarmed. L. not fascicled).

x L. pubescent. Stipules persistent or deciduous.

Small hoary pubescent tree. Stipules recurved. Fls. and frs. small, panicled.	16	295	Wendlandia.

Small dark green tree. Stipules erect deciduous. Fls. m. s. in heads, fr. a pseudocarp.	17	308	Morinda (var.).

xx L. glabrous (exc. sometimes in nerve axils), Shining.

L. large 6—10". Bark brown. Fls. m. s. white. Fr. a pseudocarp.	18	308	Morinda.
L. large 5—10". Bark white. Fls. very large, white solitary. Fr. 1—1·5" (289).	19	299	Gardenia latifolia.
L. 4—6" elliptic. Petiole ·5". Fls. small in dense axillary umbellate cymes.	20	304	Canthium didymum.
L. 3—6", oblong. Petiole under ·25". Fls. small, white, in dense terminal panicles.	21	307	Ixora parviflora.

(3) Small tree. Stipules minute, not interpetiolar caducous. Branchlets with 4 stipular lines.

L. 1·7—3·25". Peti. ·1—·15". Fls. minute	22	107	Euonymus.

(4) Stipules altogether absent.

(*a*) Glands or scales present in the leaves (visible as translucent dots) or on the leaves (lower surface) or petiole. Glands sometimes obscured by dense tomentum.

x Glands visible as translucent dots. L. with numerous fine sec. n. glabrous (Myrtaceæ).

Large or m. s. tree with brown and crimson blaze. L. ell. 3—6".	23	270	Eugenia Jambolana.
Small tree along river beds. L. 3—5" lanceolate.	24	271	Eugenia Heyneana.

xx Glands visible as minute black dots on under surface (Melastomaceæ).

Small tree. L. glabrous with obscure nervation 1·5—2·5". Fls. blue.	25	276	Memecylon.

xxx Glands visible as glistening dots on under surface. Fls. small (Verbenaceæ).

Small tree. L. 3·5—6" nearly glabrous. Fls. white.	26	400	Premna barbata.

Tree m. s. L. 5·5—10″ villous or pubescent. Fls. white.	27	401	Premna gmelinoides.
Tree m. s. L. 5—8″ densely stellately yellow tomentose. Fls. white.	28	402	Premna tomentosa.
Tree m. s. L. 6—12″ densely stellately white tomentose. Fls. pink. Fr. small white.	29	397	Callicarpa.
Tree (Teak) L. 10—18″ and over 6″ broad, covered between nerves when old with hard white tomentum, densely stellate tomentose when young. Fr. dry.	30	398	Tectona.

xxxx L. with 1—2 large tubercular glands at base or on top of petiole, oblong or ell., 5—9″.

Bark smooth greenish white. L. glabrous. Petiole rarely ·3″.	31	261	Terminalia Arjuna.
Bark rough, nearly black. L. rarely glabrous. Peti. ·2—·4″.	32	260	Terminalia tomentosa.
Bark with shallow cracks, brown. L. silky or glabrescent, ovate-oblong. Peti. over ·4″.	33	262	Terminalia Chebula.

(*b*) Glands or scales absent. (1) Surface not hidden by tomentum.

x L. smooth and glabrous or but slightly hairy when young.

o L. sessile or subsessile (peti. rarely ·15″).

Straight tree. L. 2—5″ ell. to ovate-lanceolate.	34	277	Lagerstrœmia parviflora.
Low tree with rounded crown. L. 1·5—3″ ovate or orbicular.	35	354	Strychnos potatorum.
Small tree, often spinescent. L. ·5—1·25″ rhomboid with cuneate base.	36	279	Lawsonia alba.

(1) Microscopic glands, not usually detectable in the field, may be present in 36, 40 and 43.

oo L. distinctly petioled.

Straight tree. L. 2—4″ ell. obtuse. Peti. ·25—·75″. Fls. greenish, capitate.	37	264	Anogeissus latifolia.
Small straight tree. L. 1—2·5″ acute. Peti. slender ·5″. Fls. small purple, panicled.	38	421	Santalum.
Small tree. L. 3·5—8″. Sec. n. about 10. Peti. ·5—1″. Fls. white.	39	326	Linociera.
Small bushy tree. L. 2—6″. Sec. n. 3—4. Peti. ·5—1·5″. Fls. white.	40	397	Premna latifolia.

xx L. silky, pubescent or villous, at least beneath. Not scabrid.

Bark white smooth. L. 2—4″ tomentose or pubescent (37).	41	264	Anogeissus latifolia (var.)
Bark dark rough. L. 1·5—2″ silky ...	42	265	Anogeissus acuminata.
Bushy tree. L. 2—6″ somewhat aromatic when crushed, shortly hairy or pubescent.	43	397	Premna latifolia.
xxx L. very scabrid. Small tree with drooping 4-angled rough branchlets.	44	324	Nyctanthes.

** Leaves palmi-nerved [*i.e.*, with 3 or more strong nerves, including the midrib, starting from the top of the petiole or close to base of midrib.]

† L. pubescent, villous or gland-dotted beneath.

L. broadly ovate cordate. Hairs stellate or underside glaucous.	45	404	Gmelina arborea.
L. elliptic or oblong, villous or pubescent and glandular beneath.	46	401	Premna gmelinoides.
L. ovate, and shoots with fulvous stellate tomentum.	47	402	Premna tomentosa.
Small tree. L. oblong, nearly glabrous, with scattered glands beneath.	48	400	Premna barbata.
Small tree. L. ovate, shortly villous beneath.	49	399	Premna latifolia.

†† L. glabrous (the glaucous form of 45 appears glabrous under a weak lens. No. 48 is also glabrous sometimes when quite mature).

L. shining ovate to sub-orbicular. Peti. ·3—·5″ long.	50	353	Strychnos Nux-vomica.
L. elliptic to ovate. Peti. 0—·2″ ...	51	354	Strychnos potatorum

§§ Margins of the leaves not entire. (See also 32, 33 which are sometimes toothed or denticulate esp. in seedlings and No. 45 which is coarsely toothed as a seedling.)

† Leaves smooth and glabrous.

Small tree with crenate or serrulate leaves 2—6″ and slender sec. n.	52	110	Elæodendron.

†† Leaves pubescent or hairy or, if nearly glabrous, then glandular.

Small tree. L. 3·5—6″ usually with few coarse teeth (No. 48).	53	400	Premna barbata
Tree m. s. L. 5—10″ with aromatic odour, coarsely toothed (No. 46).	54	401	Premna gmelinoides.
††† Leaves scabrous. Small tree (No. 44).	55	324	Nyctanthes.

B. Leaves alternate [see also 31 and 32 which have sub-opp. and sometimes alt. leaves, and quickly growing shoots of other trees with normally opposite leaves].

§ Margins or leaves quite entire or tip emarginate (exc. Nos. 126 and 122. See also 161).

* L. penni-nerved [see also some Ficus under ** in which lateral basal nerves are often very weak. Nos. 61, 95, many Euphorbiaceæ and others have often sec. n. close to base].

† Juice milky (sometimes sub-watery in 62 Streblus).

(1) Branches thick and fleshy with pairs of stipular prickles persisting after fall of leaves.

Branches ridged with interrupted lines of tubercles bearing the prickles (or leaves).	56	434	Euphorbia neriifolia.

Branches terete, the prickles on quite flat cushions.	57	433	Euphorbia nivulia.
(2) Branches green fleshy fistular unarmed. L. very small or O.	58	432	Euphorbia Tirucalli.

(3) Branches woody (very thick and rather fleshy in 64), unarmed.

(*a*) Stipules large, enclosing the terminal bud, falling on the expansion of the leaf and leaving a very evident annular scar on the branchlets (Moraceæ).

x Fls. and minute fruits contained in closed fleshy receptacles 'Figs.'	59	...	Ficus (see**)
xx Fls. and fruits on the outside of large fleshy receptacles. L. 4—8″. Jack fruit.	60	482	Artocarpus integrifolia.

(*b*) Stipules large, deciduous, leaving a small scar each side of the petiole base (Moraceæ).

Leaves 6—10″, tomentose beneath, sec. n. strong 10—14 each side.	61	481	Artocarpus Lakoocha.

(*c*) Stipules small, subulate, erect and persistent (Moraceæ).

Small tree with very scabrous leaves 1—3″ long. Juice sometimes sub-watery.	62	464	Streblus.

(*d*) Stipules entirely absent.

Tree with rounded crown and tomentose twigs. L. clustered 5—8″.	63	314	Bassia.
Small or large tree. L. obovate-oblong clustered 2—4″ shining glabrous.	64	315	Mimusops hexandra.
Small cultivated tree. L. elliptic acute glabrous (exc. very young).	65	316	Mimusops Elengi.
Small scraggy garden tree. L clustered large lanceolate glabrous 6—15″. Sec. n. strong.	66	329	Plumeria.

†† Juice not milky (see also 62 Streblus) (Fr. with milky juice in Casearia).

(1) Leaves with translucent dots (Secretory cells containing resin and turning brown when dry in the Anonaceæ [1] permanently translucent in Samydaceæ, crystal cells in Alangium, oil cavities in Rutaceæ).

(*a*) Branches armed with axillary thorns. Leaves scented (Rutaceæ).

L. over 3″ long. Petioles often winged. Fls. m. s. (151—153).	67	86	Citrus.
L. under 3″ long, tip emarginate. Fls. small. Thorns small.	68	85	Atalantia.

(*b*) Branches unarmed. L. aromatic when bruised (Lauraceæ, Anonaceæ).

x L. permanently pubescent, at least, beneath.

Small tree. L. 4—9″ oblong. Sec. n. 7—12, tertiary n. strong scalariform, Peti. ·25—·75″.	69	425	Litsæa polyantha.
Small tree. L. 3—8″ ell. Sec. n. 8—10, tertiary n. fine. Peti. ·75—2″.	70	424	Litsæa sebifera (var.).
L. 5—10″ broadly ell. or ovate. Sec. n. 10—12, tertiary n. fine irregular. Peti. ·2—·25″.	71	6	Miliusa.
L. 4—7″ lanceolate acuminate. Sec. n. 6—9. Peti. ·2—·25″.	72	4	Polyalthia cerasioides.
L. 2—6″ ovate or oblong. Sec. n. 5—10. Peti. ·2—·25″.	73	7	Saccopetalum.

xx L. Glabrescent (exc. on nerves in 74).

Small tree with tomentose shoots. L. ell. Peti. slender (No. 70).	74	424	Litsæa sebifera.
Straight tree pyramidal crown. L. 5—8″ narrowly lanceolate undulate. Gardens.	75	5	Polyalthia longiflora.

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(1) The dots are often very minute in Anonaceæ but are quite practicable, field characters in most. In Miliusa they are scarcely more translucent than the surrounding cells and Miliusa is therefore also included in the next category.

Small tree. L. oblong or oblong-lanc. obtuse 2—4 rarely 6". (Custard apple).	76	8	Anona squamosa.
Small tree. L. oblong acute 5—8". Cultivated only.	77	9	Anona reticulata.

(*c*) Branches unarmed. Leaves not scented nor aromatic.

x L. permanently pubescent or tomentose.

Small tree. L. oblong 2—7". Sec. n. 7—10". Translucent dots mostly elongated.	78	282	Casearia tomentosa.

xx L. glabrous or glabrescent.

Small tree. L. elliptic 4—8" usually crenate. Sec. n. 7—10. Dots often elongated.	71	283	Casearia graveolens.
Small tree. L. glabrous thick shining oblong-oblanceolate 2—5".	80	458	Gelonium.
(*d*) Branchlets often ending in a thorn. L. not scented, narrow 3—6". Gland pits with tufts of hair in the axils of several of the sec. n. beneath.	81	290	Alangium.

(2) Leaves with or without translucent dots. Dots (secretory cavities) appearing red or yellow, by reflected light, abundant on the leaf margins and floral structures (Myrsinaceæ).

Small tree with young parts rusty pubescent. L. ell. to obovate 2—6". Peti. ·3—·5".	82	312	Embelia robusta.
Small tree with rather fleshy glabrous leaves 4—8". Peti. ·25" stout.	83	313	Ardisia solanacea.

(3) Leaves without translucent or red dots. (Opaque dots due to cystoliths visible on surface of Holoptelea when dry.)

(*a*) Leaves permanently pubescent or tomentose beneath, at least on the nerves.

x L. large, *i.e.*, larger leaves on the shoots over 6" long.

L. 8—18″ often clustered, felted with grey papillæ between the nerves beneath.	84	139	Semecarpus.
L. mostly 6—7″, not grey felted between the nerves, oblong, obtuse. Sec. n. over 12.	85	136	Buchanania latifolia.
L. mostly 4—8″, ell. to orbicular, sec. n. 6—10. Bark black rugose.	86	319	Diospyros melanoxylon.
L. 5—10″ broadly ell. to ovate. Peti. ·25″. Bark brown or grey, not deeply cracked.	87	6	Miliusa velutina.
L. 4—8″ ovate-oblong. Peti. over ·4″. Sec. n. 8—12.	88	262	Terminalia Chebula.
L. 6—7·5″ ell.-oblong acuminate. Branches thorny. Tertiary n. fine branched.	89	318	Diospyros sp.
L. 4—10″ ell.-oblong. Trunk often thorny. L. Grey or glaucous beneath with strong scalariform tertiary n. Sec. n. 15—20 each side.	90	436	Bridelia retusa.

xx L. small or m. s., *i.e.*, larger leaves on the shoots under 6″ (rarely 6″ in 92 and 93, very rarely in 93 and 94).

Bark smooth green to red, often thorny. L. 3—6″ thinly pubescent. Peti. ·15—·3″.	91	318	Diospyros montana.
Small tree. Bark brown rough. L. 3—6″ ell.-oblong apiculate. Fl. and fr. axillary.	92	445	Glochidion velutinum.
Small bushy tree. L. 2—4 rarely 5″ obovate-lanc. or narrow-ell. acute. Fls. and small frs. in sub-solitary spikes.	93	449	Antidesma diandrum.
Small bushy tree. L. 2—4″ broadly ell obtuse. Fls. and small frs. in panicled spikes.	94	448	Antidesma Ghaesembilla.

Large tree. Bark smooth. Blaze cream to light brown. L. 2—4". Fls. before leaves, clustered.	95	461	Holoptelea.
Straight tree. Bark smooth, white. Blaze pale red. L. 2—4" ell. mostly sub-opposite. Fls. small in peduncled heads.	96	264	Anogeissus latifolia.
Bushy tree, usually thorny. Bark grey, rough. L. 1—3" ell. to obovate. Sec. n. 3—6.	97	317	Diospyros chloroxylon.
Trunk short. Bark very rough. L. 1—3" rhomboid to obovate rounded. Sec. n. 8—10.	98	14	Capparis grandis.

(*b*) L. glabrous or only somewhat pubescent when young.

x L. large, *i.e.*, larger leaves on the shoots over 6" (smaller leaves are common at the base of shoots, *vide* also 109 Ehretia).

Leaves clustered 6—12" oblong-lanceolate, coriaceous (Mango).	99	134	Mangifera.
L. clustered 4—8" broadly or obovately elliptic. Fls. small, spicate.	100	263	Terminalia belerica.
L. often clustered 6—15" obovate, some crenate. Fls. large. Fr. a large berry.	101	273	Careya arborea.
L. often clustered 3—6, rarely 9", obovate to oblanceolate, some denticulate. Fls. in long drooping racemes. Fr. angled (159).	102	272	Barringtonia.
L. 5—9" distichous oblong shining. Bark smooth grey.	103	320	Diospyros embryopteris.
L. 4—9" ell. oblong, grey or glaucous beneath with raised scalariform tertiary nerves. Trunk in young trees often thorny. Blaze crimson.	104	436	Bridelia retusa.

L. 4—8″ obovate with rounded apex, hard. Cult. (Cashew Nut.)	105	135	Anacardium.
L. 4—8″ broad-ovate shining coriaceous. Fl. panicled (Sal).	106	21	Shorea.
L. 4—7″ ovate to oblong-lanceolate shining, base rounded, often oblique, gradually tapering. Fls. axillary small clustered. Fr. globose.	107	444	Glochidion zeylanicum.
L. 3—6″ ell.-oblong or lanc., base mostly acute, apex usually cuspidate. Bark smooth. Blaze pale pink. Fr. depressed, furrowed.	108	443	Glochidion lanceolarium.

xx L. small, *i.e.*, larger leaves rarely attaining 6″ long (see also 107 and 108, also 162 Ochna which sometimes has entire leaves).

Small tree. Bark white. L. 4—5 rarely 7″. Sec. n. 5—6 with small tufts of hair in their axils.	109	362	Ehretia laevis.
Trunk short. Bark dark rough. L. 3—5″, often clustered, obovate to lanceolate (102).	110	272	Barringtonia.
Trunk sometimes with large thorns. Bark greenish to red, smooth, flakey. L. 2—5″ (91).	111	318	Diospyros montana.
Dark rough. L. 2—5″ lanceolate or narrow-oblong acuminate, glaucous beneath.	112	484	Salix.
Small bushy tree. L. 2—4, rarely 5″ obovate-lanceolate or narrow-ell. (93).	113	449	Antidesma diandrum.
Straight. Bark rough, deep brown L. 2—4, rarely 5″, scattered, stiff, ell. to linear-oblong obtuse pale beneath. Peti. ·5—·6″.	114	137	Buchanania angustifolia.

Straight. Bark white L. 2—4″ broadly elliptic, obtuse (96).	115	264	Anogeissus latifolia.
Bushy. Bark rather rough brown. Blaze pink. L. 2—4″ lanceolate to orbicular, somewhat glaucous beneath. Sec. n. 6—7 very oblique. Fr. ·25″.	116	437	Bridelia Hamiltoniana.
Bark black rough. L. 2—4″ broad elliptic or orbicular. Sec. n. 7—10 spreading.	117	438	Cleistanthus.
Bark smooth, grey. Blaze cream or brown. L. 2—4″ (95, 163).	118	461	Holoptelea.
L. distichous, broadly lanceolate, 2—3·5″, edges often wavy rarely serrate.	119	447	Putranjiva.
Branchlets clustered. L. 1—3″ arranged like the leaflets of a pinnate leaf. Cult.	120	440	Phyllanthus distichus.
L. ·3—·75″ arranged like the leaflets of a pinnate leaf.	121	439	Phyllanthus emblica.

** Leaves palmi-nerved. [See also 95, 118, 109 and others under * in which some of the sec. n. rise close to base, in Ficus lateral basal nerves sometimes very weak but exc. F. tjakela, differ in direction from the other sec. n.]

† Juice milky. Twigs with annular scars.

(1) Leaves with very inequilateral base.

L. 6—15″ oblong-lanceolate, usually serrate, larger basal lobe 3—4-nerved, small tree with figs on leafless branches.	122	478	Ficus Cunia.
L. 3—8″ sub-rhomboid, scabrous, base 3-nerved. Sec. n. 4—5.	123	465	Ficus gibbosa.

(2) Leaves with sub-equal or equilateral base.

(*a*) L. more or less pubescent or tomentose beneath. Base more than 3-nerved. Often epiphytes or with aerial roots under favourable conditions.

L. 4—8″ ovate to ell. with rounded or subcordate base, shoots and leaves beneath green, more or less hairy or pubescent on nerves.	124	466	Ficus bengalensis.
L. 2—8″ ell. ovate or obovate with cordate base, shoots and leaves beneath rusty or grey *tomentose, a glandular* slit on midrib beneath in most leaves.	125	467	Ficus tomentosa.

(*b*) L. scabrid or tomentose beneath, often lobed and toothed. Base 3—5-nerved.

Small cultivated tree, never epiphytic or with aerial roots.	126	479	Ficus palmata.

(*c*) L. often pubescent when young, finally glabrous, base 3-nerved, underside with minute green dots.

Figs in clusters from the trunk and larger branches.	127	480	Ficus glomerata.

(*d*) Young parts densely pubescent. L. not quite glabrescent beneath, base 3—5-nerved, basal nerves spreading nearly parallel to the sec. n.

Figs small clustered on small tubercles above the leaf scars.	128	475	Ficus tjakela.

(*e*) Shoots and leaves glabrous (rarely somewhat pubescent when young). Figs in pairs (1—2) in the axils of leaves or fallen leaves. Basal pair of nerves more oblique than sec n. and often with subsidiary basal nerves below them. Often epiphytic when young.

L. 1·5—3″ ell. to obovate with cuneate base. Sec. n. very slender 5—12 with intermediate nearly as strong. Petiole ·25—·5″.	129	468	Ficus retusa.
L. 3·5—4″ ovate, base rounded, apex shortly suddenly acuminate.	130	471	Ficus Arnottiana, var. courtallensis.

L. 3—5″ ovate coriaceous with oblique or rounded base; not acuminate; with translucent dots (punctulate) when green, becoming minute tubercles when dry.	131	473	Ficus Tsiela.
L. 3—6″ oblong to ovate with rounded base: scarcely coriaceous, shortly acuminate, not punctulate nor tuberculate.	132	474	Ficus infectoria.
L. 5—6″ ovate, gradually tapering to acuminate tip, punctulate.	133	472	Ficus Rumphii.
L. 4—7″ broadly ovate with cordate base, shortly suddenly acuminate.	134	470	Ficus Arnottiana.
L. 4—7″ ovate or orbicular with sudden fine acumen one-third to half as long as the entire leaf.	135	469	Ficus religiosa.

†† Juice not milky. Twigs without annular stipular scars.

(1) Leaves tomentose beneath.

Small tree with leaves 1—3″ long usually serrulate and armed with stipular prickles.	136	112	Zizyphus Jujuba.
Small tree with large broadly ovate leaves 4—10.″ Petiole stout 1·5—3″.	137	361	Cordia Macleodii.
Small tree with oblong ovate or obovate leaves 2—5″. Petiole ·75—1·5″.	138	360	Cordia Wallichii.

(2) Leaves pubescent or glabrescent beneath.

L. 2—5 5″ oblong, orbicular or obovate. Sec. n. about 4 usually pubescent in the axils. Petiole rather slender ·75—1·2″.	139	357	Cordia Myxa.

L. attaining 8 by 5·5″ ovate with cordate or sub-cordate base.	140	359	Cordia latifolia.
Branchlets often ending in thorns. L. narrow 3—6″, 3-nerved, gland pits or tufts of hair in nerve axils beneath and usually minutely pellucid punctate.	141	290	Alangium.
L. as broad as or broader than long 4—7″ with 7—11-nerved base glabrous.	142	230	Bauhinia retusa.
(3) L. glandular pubescent or hoary and with small red glands beneath, ovate or rhomboid 3—6″.	143	454	Mallotus.

§§ Lateral margins of leaves quite entire but apex deeply 2-lobed (see also 68 Atalantia). Palmi-nerved.

Small L. 2—3″ lobed less than half-way, loosely pubescent beneath.	144	225	Bauhinia tomentosa.
Bark rough grey. L. 1—2″ broader than long, tomentose to pubescent beneath, basal n. 7—9. Fls. small in simple racemes.	145	226	Bauhinia racemosa
As in 145 but L. 2—4″ puberulous beneath when old, not acid.	146	226	B. racemosa (var.).
Bark brown-grey nearly smooth. L. 1—4″ glabrescent or puberulous beneath, acid, basal nerves 9—11. Fls. subregular white in corymbose racemes.	147	227	Bauhinia malabarica.
L. 2·5—6″ grey glaucous and puberulous beneath, lobes rounded, basal nerves 13—15 rarely only 11. Fls. large irregular, buds cylindrical.	148	228	Bauhinia variegata.

L. 2·5—7″ green	glabrous or puberulous beneath, lobes angular at tip, basal n. 9–11. Fls. large irregular, buds sharply angled.	149	229 Bauhinia purpurea.

§§§ Margins of leaves not entire, *i.e.*, more or less crenate, toothed or with excurrent nerves. (See also Nos. 122, 126 above. For deeply lobed leaves see §§§§.)

* Leaves penni-nerved.

† Juice somewhat milky.	Small tree with scabrid leaves 1—3″ (171).	150	464 Streblus.

†† Juice not at all milky.

(1) Leaves more or less gland-dotted or pellucid punctate.

(*a*) Leaves lemon-scented when bruised. Branches with axillary thorns. Cultivated small trees.

Young shoots purple.	Petals tinged with red. Fruit ovoid or oblong (Lemon).	151	86 Citrus medica.
Young shoots pale.	Petals pure white. Fruit round or oblate (Orange).	152	87 Citrus Aurantium.
Young shoots and L.	pubescent beneath. Fruit very large (Pumelo).	153	88 Citrus decumana.

(*b*) Leaves not lemon-scented. Branches unarmed. Small jungle trees.

Twigs and leaves	beneath pubescent or tomentose. L. 3—7″ oblong crenate.	154	282 Casearia tomentosa.
Twigs and leaves	glabrous. L. 4—8″ ell., ell.-oblong or ovate crenate.	155	283 Casearia graveolens.

(2) Leaves not gland-dotted nor pellucid punctate.

(*a*) Leaves very large, *i.e.*, exceeding 12″. Sec. n. very strong, numerous, parallel.

Small crooked tree. L. obovate to elliptic 12—20". Petiole distinct 1—3".	156	2	Dillenia aurea.
Mod. sized tree. L. ell. 12—36" decurrent below on a short amplexicaul base.	157	3	Dillenia pentagyna.

(*b*) Leaves large, *i.e.*, the larger exceeding 6" (see also No. 161 below).

Small tree with stringy bark, red blaze. L. 6—15" obovate crenate-denticulate.	158	273	Careya arborea.
Small tree with dark rough bark and soft pink blaze. L. rarely over 6" (102).	159	272	Barringtonia.

(*c*) Leaves small, very rarely attaining 6" (see also 159)

Small L. 3—5, rarely 6—7", ell. to ell.-oblanceolate finely spinulose-serrate when young, old serrulate, green, glabrous.	160	93	Ochna squarrosa.
Small L. 3—5, very rarely 6", broadly ell. or obovate subsessile, shallowly crenate, rarely entire, pale glaucous. Sec. n. fine, numerous.	161	92	Ochna Gamblei.
Small, often thorny. L. 2—3" crenate-serrate, glabrous or somewhat pubescent beneath. Sec. n. 3—5, often one pair near base, oblique.	162	18	Flacourtia Ramontchi.
Large L. 2—4" broadly oblong or ovate, rarely coarsely toothed except in seedlings. Sec. n. sometimes close to base (95, 118).	163	461	Holoptelea.

*** Leaves palmi-nerved (see also 162 and 163 above).

† L. with only 3 strong basal nerves, small subsidiary sometimes present.

(1) Branches with stipular thorns. Leaves serrulate. Smal trees.

L. 1·5—3″ densely grey or brown tomentose beneath, cymes sessile.	164	112	Zizyphus Jujuba.
L. 1·5—3″ more or less pubescent beneath. Cymes shortly stalked.	165	115	Zizyphus Xylopyra.

(2) Unarmed (some branches of 165 also unarmed), exstipulate.

Small tree. L. 2—5·5″ repand-dentate, base cuneate to rounded.	166	357	Cordia Myxa.
Small or m. s. tree. L. as in 166 but densely stellately tomentose beneath.	167	360	Cordia Wallichii.
Small tree. L. attaining 8″ base, rounded or sub-cordate, tertiary n. strong.	168	359	Cordia latifolia.

(3) Unarmed. Young leaves stipulate. Small trees.

L. 3—6″ ovate-lanceolate, acuminate silky or silvery beneath.	169	462	Trema orientalis.
L. 2—3″ ovate-lanceolate, scarcely acuminate, very scabrous both sides.	170	463	Trema politoria.
Branched low down. L. 1·5—3″ rhomboid, ell. or obovate, very scabrous both sides (150).	171	464	Streblus asper.
L. 3—6″ narrow-elliptic or lanceolate acuminate glabrous or with scattered stellate hairs.	172	63	Grewia disperma.

†† L. mostly broad with more than 3 strong basal nerves, strong sec. and tertiary nerves.

L. broadly-ovate to ovate-oblong green glabrescent with inequilateral cordate base. Bark smooth. Petiole rather slender ·3—1". Stipules falcate.	173	64 **Grewia tiliæfolia.**
L. ovate, oblong or ell. with oblique, not cordate, base. Underside often persistently tomentose. Petioles under ·5" stout. Stipules linear.	174	66 **Grewia celtidifolia.**
L. broadly-ovate, ell. or orbicular, oblique or subequal at base, grey-green tomentose beneath. Bark black rough with deep crimson blaze.	175	68 **Grewia rotundifolia.**
L. broadly-ovate, base cordate, tomentose beneath. Peti. 1—4" (178).	176	56 Eriolæna.
L. broadly-obovate, base somewhat cordate, tomentose beneath. Peti. ·25—·3" Fls. red irregular axillary. Fr. spiral.	177	54 Helicteres.

§§§§ Leaves strongly angled or lobed. Base more or less cordate.

* Leaves penni-nerved. Young plants of Artocarpus, Holoptelea.

** Leaves palmi-nerved (see also 173 which is sometimes somewhat lobed). Base cordate.

† Margins crenate, serrate or toothed.

Small tree. Petiole 1—4". Fls. yellow 1·5—2" on long peduncles (176).	178	56 Eriolæna.
Small tree. Petiole ·25—·3". Fls. brick-red, irregular (177).	179	54 Helicteres.

M. s. or large. Petiole 3—8". L. roundish 6—12". Fls. large white.	180	55	Pterospermum.
M. s. or large. L. roundish 8—18". deeply 5—7-lobed, each large lobe mostly 3-partite or with 3 large teeth, not otherwise serrate.	181	52	Sterculia villosa.

†† Margins or lobes entire (or sinuate in 184 Kydia. See also 181).

Large tree, bark smooth, greenish to grey with papery exfoliation. L. 8—18" diam., tomentose beneath.	182	51	Sterculia urens.
Large tree, bark grey not papery. L. 6—12" diam., stellate, glabrescent.	183	53	Sterculia colorata.
L. roundish 4—6", sometimes scarcely lobed, tomentose beneath with a gland on one to three of the nerves.	184	49	Kydia.
Small straight, soft-wooded with pale fluted bark. L. 3—8", young tomentose.	185	17	Cochlospermum.
Small crooked soft-wooded L. (rarely some not lobed) 4—6", glabrous. Cult.	186	450	Jatropha Curcas.

II. Leaves composed of two leaflets.

Large graceful tree with blue-green foliage. L. like those of a Bauhinia but split quite to the base into two lflts. 1—3" long.	187	232	Hardwickia.
Small very thorny tree with grey-green foliage. Lflts. ell. or lanceolate.	188	81	Balanites.

III. Leaves composed of three leaflets.

A. Leaves opposite, usually aromatic when bruised, digitate.

Small or m. s. Lflts. 3—5 lanceolate, 2—5″, glabrous except along midrib beneath. Fls. in divaricate loose cymes.	189	407	Vitex leucoxylon.
Small. Lflts. 3 only, 3—7″ glabrous. Peti. often winged. Fls. in narrow oblong cymose panicles.	190	408	Vitex peduncularis.
Small. Lflts. 3, rarely 5, pubescent beneath, panicles broad.	191	409	Vitex altissima.

B. Leaves alternate.

§ L. digitately 3-foliolate, *i e.*, leaflets, or their petiolules, all arising from the end of common petiole (cp. §§).

L. pellucid glandular with straight axillary thorns.	192	90	Aegle.
L. not glandular. Small unarmed tree with showy flowers.	193	13	Cratæva.

§§ L. pinnately 3-foliolate, *i.e.*, with a distinct axis or 'rhachis' above the petiole on which the first pair of leaflets is laterally inserted and the third is terminal. Lflts. with very short petiolules and often stipellate.

* Branches with numerous prickles.

Bark thick corky. Lflts. large, tomentose beneath, often repand.	194	173	Erythrina suberosa.
Bark thin. Lflts. large glabrescent.	195	172	Erythrina indica.

** Branches without prickles.

Bark nearly black, blaze streaked crimson, exuding red juice. Lflts. glabrous or downy beneath, end one orbicular to obovate 3—6″.	196	164	Ougeinia.

Bark nearly black, blaze crimson exuding red juice. Branchlets knotted, end lflt. orbicular with rhomboid base 6—8" silky beneath, rarely only the end leaflet present.	197	176	Butea frondosa.

IV. Leaves composed of 4 leaflets (see also 214).

Pretty tree with spinose stipules. L. with a pair of pinnæ, each pinna with a pair of leaflets 1—2" long.	198	257	Pithecolobium.
Large unarmed tree. Lflts. 3—10" long, basal pair smaller.	199	130	Schleichera.

V. Leaves composed of 5 to many leaflets.

A. Leaves opposite (upper leaves often crowded and alternate in Stereospermum).

§ L. digitate, *i.e.*, leaflets, or their petiolules, all arising direct from the top of the petiole, without interposition of a rhachis.

Lflts. 3—5 lanceolate 2—5" (189).	200	407	Vitex leucoxylon.
Lfts. 3, rarely 5, pubescent beneath (191).	201	409	Vitex altissima.

§§ L. simply pinnate, *i.e.*, with a distinct axis or 'rhachis' above the petiole, along which the leaflets or their petiolules are laterally inserted, often with a terminal end lflt. in addition. Rhachis not branched—cp. §§§ (Bignoniaceæ).

Small tree. Rhachis 2—5". Lflts. 5—7 roundish to obovate, pubescent, ·5—2·5".	202	373	Dolichandrone.
L. 9—12" Lflts. 5—7 oblong to ovate-lanceolate subacuminate glabrescent 3—5".	203	325	Schrebera.
L. clustered. Lflts. 7—11 ell. caudate glabrous 3—5".	204	376	Stereospermum chelonoides.

As in 204 but acute or acuminate, slightly pubescent beneath 2—7·5". Petiolule slender ·3—·5".	204 (*a*)	376	S. chelonoides (var.).
L. clustered. Lflts. 5—11 broadly ell. or oblong, suddenly acuminate, 3—7" pubescent. Petiolule stout ·05—·25". Inflorescence viscous.	205	377	Stereospermum suaveolens.
Large tree. L. clustered. Lflts. 5—9 ell. or oblong, obtuse or suddenly acuminate 2·5—8" glabrescent, mostly crenate-serrate. Petiolule 0—·2".	206	375	Heterophragma.

§§§ L. twice pinnate, *i.e.*, primary rhachis with one or more pairs of branches, secondary rhachides, interposed between the rhachis and the leaflets or thrice pinnate, *i.e.*, the secondary rhachides again branched. (The secondary rhachis with its leaflets is termed a pinna) (Bignoniaceæ).

Small tree. Only 1—2 short pinnæ at base of main rhachis, rest simply pinnate (202).	207	374	Dolichandrone.
L. 1—3 ft., 2—3 pinnate. Lflts. ell. to ovate 2—6" pale or silvery beneath, entire or serrate. Large forest tree. Pod woody.	208	378	Stereospermum xylocarpum.
L. 1—3 ft., 2—3 pinnate. Lflts. ovate-lanceolate acuminate 2—3", sinuate or crenate. Tall avenue tree. Pod slender.	209	372	Millingtonia.
Small soft-wooded tree with 2—3 pinnate leaves 2—6 ft. Lflts. ovate 4—5" ternate on the ultimate pinnæ. Pod flattened.	210	373	Oroxylum.

B. Leaves alternate (see remarks under A).

§ Leaves digitate.

Branches spreading. Bark pale often with conical prickles. Lflts. 5—7, 6—12″.	211	50	Bombax.

§§ Leaves simply pinnate (see explanation under A, see also 120, 121 and 241).

* Leaves pari-pinnate, *i.e.*, rhachis not ending in an odd leaflet.

† Leaflets pellucid-punctate with glands.

Lflts. 10—20 each side of rhachis, unequal-sided, about 1″ long.	212	103	Chloroxylon.

†† Lflts. not pellucid-punctate but with small gland scales on under-surface.

L. 9—18.″ Lflts. 3—6 prs., 2—4″ long, mostly obtuse.	213	101	Soymida.

††† L. without pellucid glands or scales (glandular hairy in 240).

Lflts. 2—3 prs., terminal pair longest 3—7″. Inflorescence terminal.	214	132	Sapindus.
Large tree. Lflts. 2—4 prs., terminal pair longest 6—10″. Inflorescence axillary.	215	130	Schleichera.
Small cultivated tree. Lflts. 3—6 prs., lanceolate 3—9″. Fls. corymbose scarlet.	216	223	Saraca.
Lflts. 4—8 prs., ovate acute or acuminate 2—5″. Fls. yellow racemed.	217	213	Cassia Fistula.
Lflts. 6—10 prs., ell.-oblong, rounded or mucronate 1·5—2·5″. Fls. yellow panicled.	218	214	Cassia siamea.
L. 1—2 ft. Lflts. 6—16 prs., sometimes alternate, lanceolate, acuminate, 3—6″.	219	102	Cedrela.

L. 3—6″. Lflts. 10—20 prs., linear-oblong ·3—·6″.	220	224	Tamarindus.
Small tree. L. 6—18″. Lflts. 10—30 prs., linear-oblong 1—1·5″. Cultivated.	221	157	Sesbania grandiflora.

** Leaves imparipinnate, *i.e.*, rhachis ending in a single terminal leaflet.

† Leaflets pellucid punctate with glands (Rutaceæ).

Thorny. L. rhachis not, or very narrowly, winged. Lflts. 5—7 obovate obtuse entire or tip sometimes crenulate.	222	89	Feronia.
Thorny. L. rhachis with large semi-obovate wings. Lflts. 5—9 crenate 1—3″.	223	84	Limonia.
Unarmed. L. rhachis not winged. Lflts. 5—9 entire shining ·75—3″ (382).	224	82	Murraya exotica.
Lflts. 10—25 entire or crenulate, usually acuminate and pubescent, 1—3″ (386).	225	83	Murraya Koenigii.

†† Leaflets not pellucid punctate.

(1) Margins of leaflets entire (toothed sometimes in seedlings).

(*a*) Lflts. (below the terminal) in pairs, opposite or sub-opposite.

L. 1—2 ft. Lflts. opp. to alt. rarely imparipinnate (219).	226	102	Cedrela.
L. 6—12″. Lflts. 3—4 prs., 3—5″ pubescent glabrescent oblong suddenly acuminate. Sec. n. 5—12. Petiolule slender ·3—·5″.	227	97	Bursera.
Lflts. 3—4 prs., 2·5—5″, stellate-pubescent or glabrescent, more or less ovate. Petiolules stout under ·25″.	228	138	Odina.

Lflts. 2—3 prs., 2—5" ovate, shortly bluntly acuminate, glabrous shining, petiolule slender ·25". Sec. n. about 5.	229	203	Pongamia.
Lflts. 3—5 prs., with smell of mangoes, 3—6", ell.-oblong acuminate. Sec. n. 10—12.	230	140	Spondias.

(*b*) Lflts. all alternate (see also 226).

Lflts. 3—5, rhomboid or roundish, cuspidate 1—3".	231	197	Dalbergia Sissoo.
Lflts. 5—7, orbicular, obtuse or emarginate 1—4".	232	198	Dalbergia latifolia.
Lflts. 9—15, ell. to obovate or oblong, ·75—2·25". Wood normal.	233	200	Dalbergia lanceolaria.
Lflts. 9—15, round to oblong, ·5—1·5". Wood with alternating bands of xylem and phlœm.	234	199	Dalbergia paniculata.

(2) Margins of leaflets crenate, serrate or toothed. Lflts. opposite, rarely sub-opp. (or in 237 alternate and sometimes lacking the terminal leaflet).

Small tree with long weak branches. Lflts. 3—5 prs., ·75" (at base of shoot) —3·5" variously toothed or sub-lobed.	235	100	Cipadessa.
Lflts. 3—4 prs., 3—5" serrate, oblong, suddenly acuminate (227).	236	97	Bursera.
Lflts 4—8 prs., 1—3", obliquely falcate-lanceolate, coarsely serrate glabrous.	237	98	Azadirachta.
Lflts. 6—12 prs., ovate-lanceolate, crenate, pubescent.	238	96	Garuga.
Lflts. 9—16 prs., lanceolate, coarsely crenate-serrate, more or less pubescent above and glaucous beneath, sessile or subsessile.	239	95	Boswellia.

Lflts. 10—16 prs., with rhachis often terminating in undeveloped lflts., deeply serrate, or sub-lobed, hoary tomentose and glandular with strong smell	240	91	Ailanthus.

§§§ Leaves twice pinnate (Leguminosæ exc. 265 and 266).

* Main rhachis much reduced and mostly ending in a thorn at the base of which the secondary rhachides are clustered and resemble simply pinnate leaves.

Small thorny tree. Pinnæ with flattened green rhachis 4—9″. Lflts. small or 0.	241	212	Parkinsonia.

** Main rhachis short bearing only 1 pair of pinnæ.

Tree with straight stipulary thorns. Lflts. only 2, 1—2″ long.	242	257	Pithecolobium.
Unarmed. Lflts. 2—3 prs. or up to 7 prs., 2—8″ long.	243	233	Xylia.

*** Main rhachis bearing several pairs of pinnæ (Mimoseæ exc. 260, 263 and 264).

(1) Branchlets armed with axillary or terminal straight thorns. Lflts. very small.

Small tree. L. 1—3″ long. Lflts. ·05—1″ long. Fls. in tassel-like spikes.	244	235	Dichrostachys.

(2) Branchlets armed with paired (stipular) prickles. Lflts. small linear under ·5″ (exc. 251).

Small tree. Prickles short straight. Rhachis 1·5—2″, pinnæ 1—1·5″ (390).	245	240	Acacia Farnesiana.
Small. Prickles stout long white 1—2″. Pinnæ 2—5 prs. Lflts. 6—9 (rarely 10—12) prs.	246	242	Acacia eburnea.

Bark black deeply cracked. Prickles slender long white ·5—2″. Pinnæ 3—6 prs. Lflts. 10—20 prs. Fl. heads yellow.	247	241	Acacia arabica.
Bark white (dark below on old trunks). Prickles ·25—1″. Pinnæ 5—10 prs. Lflts. 12—30 prs. Fl. heads white, panicled.	248	243	Acacia leucophlæa.
Bark grey. Prickles short slightly curved. Pinnæ 3—5 prs. Lflts. 10—20 prs. ·25—·35″ long, glaucous beneath.	249	245	Acacia ferruginea.
Bark black. Prickles short hooked. Pinnæ 7—22 prs. Lflts. mostly 12—20 prs. ·1—·2″ long, not glaucous.	250	244	Acacia Catechu.
Bark brown. Prickles curved. Pinnæ 2—4 prs. Lflts. ·75—1·5″.	251	246	Acacia lenticularis.

(3) Lflts. resembling those of Sect. (2) but prickles not stipular, numerous small or obsolete on some branches, sometimes minute on the leaf rhachis.

Small tree with pale bark and pale pink blaze. Pinnæ 10—27 prs. Lflts. 25—40 prs.	252	247	Acacia Donaldi.

(4) Prickles or thorns absent. Lflts. mostly over ·5″ (exc. 253 and 254).

(*a*) Forest trees (exc. 257).

Small tree with yellow tomentose shoots. Pinnæ 6—15 prs. Lflts. numerous ·25″.	253	256	Albizzia amara.
Large tree. Bark grey. Shoots tomentose. Pinnæ 5—10 prs. Lflts. 20 prs., larger ·5—·6″.	254	254	Albizzia Thomsoni.

Bark brown or grey. Pinnæ 2—5 prs. Lflts. 6—24 prs., oblong or falcate ·6—1·2″, two to three times longer than broad. Fl. heads panicled.	255	252	Albizzia odoratissima.
As above. Lflts. 6—11 prs. 1—1·9″. Fl. heads panicled. Peduncles under 1·25″. Fls. sessile. Pods purplish-green to red-brown.	256	253	Var. lebbekifolia.
Bark *grey cinereous. Pinnæ 2—4 prs.* Lflts. 6—8 rarely up to 13 prs., oblong, 1—1·5″, rarely twice longer than broad. Fl. heads on long axillary peduncles 2—4″ long. Pods straw-yellow.	*257*	*251*	*Albizzia* Lebbek.
Bark greenish-white. Lflts. 1—2·3″ broader at base on the upper side of the principal nerve.	258	255	Albizzia procera.

(*b*) Planted roadside, village or garden trees.

Large tree with many main branches. Lflts. 1—2″ rhomboid with diagonal main nerve.	259	258	Enterolobium.
Handsome dark-foliaged tree with brown-tomentose shoots. Pinnæ 8—10 prs.			
Lflts. 10—15 prs., narrow oblong ·5—·75″. Fls. yellow, not in heads.	260	209	Peltophorum.
Tall light-foliaged tree. Pinnæ 20—30 prs. Lflts. over 60 prs.	261	236	Parkia.

Small tree. Pinnæ 4—8 prs. Lflts. 10—15 prs. linear glaucous ·4—·5″.	262	237	Leucæna.
Spreading tree. Pinnæ 8—20 prs. Stipules large pinnate. Fls. gaudy orange and red (Gold Mohur).	263	211	Poinciana regia.
Pinnæ 3—8 prs. Lflts. 10—20 prs. ·3″ obtuse. Stipules linear caducous. Fls. large yellow.	264	210	Poinciana elata.
§§§§ Leaves twice to thrice pinnate. Lflts. more or less ovate. Cultivated trees.			
Pinnæ 3—4 prs. Lflts. ·5—·3″ ovate-lanceolate acuminate, mostly serrate.	265	99	Melia.
Pinnæ 4—6 prs. Lflts. ·5—·75″ ovate or obovate entire on slender petiolules.	266	141	Moringa.

Note.—This completes the Key for the Trees. The Key to Shrubs, Palms, Bamboos, Climbers and Undershrubs will be published in subsequent issues.

THE CAMPHOR CONTENT OF *CINNAMOMUM CAMPHORA* GROWN AT DEHRA DUN.

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

A camphor tree growing in the Kaunwali gardens at Dehra was felled with a view of finding out the percentage of camphor and oil in its different parts by actual distillation in the newly equipped distillery of the Institute. The girth of the tree at the base was 36½" and at the top 32". The tree was divided as follows for distillation, the wood and branches being reduced to small chips:—(1) Main stem, (2) Large branches, (3) Small branches, (4) Twigs up to 4½" thick with green bark on, and (5) Leaves together with very short twigs. The distillation was for

the most part carried on at 20—25 lbs. pressure, this being raised towards the end to 40 lbs. A charge of about 100 lbs. took the somewhat long time of 5 hours to deal with. This was evidently due to the fact that the size of the old camphor condenser is not suited to the size of the still, and consequently the quantity of steam that could be admitted to the still was comparatively small. The separation of the camphor from the oil in the camphor condenser designed by the writer was very satisfactory. The diagram of this condenser has been already published in the new edition of Mr. Troup's "Manual of Forest Utilisation." The results obtained are tabulated below :—

TABLE I.

No. of Sample.	Percentage of loss at 100° C. (mostly moisture in material as placed in the still.)	Percentage of camphor obtained from the condenser.	Oil.	Fresh camph or calculated on the dry material	Oil on the dry material	Dry camphor, calculated on the dry material.
			per cent.	per cent.	per cent	per cent.
1. Stem	43·11	0·66	0·49	1·16	0·86	0·97
2. Large branches ...	21·27	0·46	0·34	0·58	0·43	0·51
3. Small ,, .	29·43	0·21	0·11	0·29	0·15	0·25
4. Twigs with green bark	27·72	0·27	0·19	0·37	0·26	0·31
5. Leaves with short twigs	51·99	0·24	0·36	0·49	0·74	0·42

In order to get at the exact percentage of the completely dry camphor as given above, it was necessary to determine the moisture in the different samples of camphor given in the above table. This determination presented some difficulty, as the moisture could not be determined in the ordinary way on account of the camphor itself being very volatile. The moisture was determined by dissolving a known weight of camphor in petroleum ether and filtering the solution in a flask, the weight of which was

known. The petroleum ether was distilled off. The last traces of petroleum ether were removed by slow evaporation at the temperature of the room. The flasks were kept loosely plugged with cotton. After about five days, no petroleum ether was left in the camphor. The loss gave the moisture.

Another method tried in the case of the four samples of camphor to check the results given by this method seems to give very satisfactory results (see below). About twenty-five grams of the wet camphor were taken in a measure cylinder and petroleum ether was poured on it from above. The camphor dissolves in the ether, leaving the quantity of water contained in it as an underlayer. This was directly read off and the moisture calculated on the camphor taken. On account of the difficulty of getting rid of the last traces of the solvent, the latter method is preferable to the former. The moisture as determined in a few samples of camphor is given below :—

TABLE II.

Description.	Moisture by Petroleum ether extract method.	Moisture by direct reading.
1. Camphor from the stem	16·70	16·58
2. Ditto ditto ; a second sample ...	15·04	...
3. Ditto from large branches	12·60	11·09
4. Ditto from small branches	14·39	...
5. Ditto from twigs with green bark ...	15·17	...
6. Ditto from the leaves of the tree grown at Dehra Dun.	13·39	...
7. Ditto from leaves from Madras ...	10·62	9·83
8. All samples mixed	13·45	13·29

The results in four cases, where moisture by direct reading was determined, are in fair agreement with the extraction method.

In conclusion, it may be pointed out that the camphor wood grown at Dehra is poor in its camphor content, as the Formosan

wood is reported to yield 3 – 4 per cent. of camphor. Compared with the percentage of camphor of dried leaves received for distillation from Ammayanayakanur, Madras, the Madras leaves have given 1·79 per cent. dry camphor calculated on the dry material, while the leaves of the Dehra tree have given only 0·42 per cent. This difference is of course mainly due to locality and climate.

NOTES ON SOME INDIAN FOREST BEETLES.

BY C. F. C. BEESON, FOREST ZOOLOGIST.

The volume on the beetles of Indian Forests which has recently been published, ("Indian Forests Insects of Economic Importance, Coleoptera," by E. P. Stebbing, London, Eyre and Spottiswoode, 1914,) contains all the information on this group collected by the Zoological Branch of the Research Institute since its formation in 1900. During the compilation of the book, however, the investigations carried out with some species, have supplied further information, which permits of a different interpretation of the facts and necessitates certain alterations in the accounts given in the book. It is thought advisable to make the additional information immediately available, so far as it affects the nomenclature of the insects concerned, especially with regard to those species of considerable economic importance, which are beginning to appear in departmental literature under incorrect specific names.

TETROPIUM OREINUM, GAHAN *(CERAMBYCIDÆ)*.

I am indebted to Mr. R. S. Hole for the following information on this species, which breeds in deodar in the North-West Himalayas, and which proved a serious pest in the 1907—1911 bark-beetle attack in the Simla Catchment Area. The first specimens obtained by Mr. Stebbing from Simla in 1909 were misidentified as *Trinophylum cribratum*, Bates, and this error appeared in print in 1911 in Forest Memoirs, Zool. Series, Vol. II, i, pp. 28—32, together with an account of the life-history based on observations collected in the Catchment Area Forests

in 1908-1909. Mr. Hole when Officiating Forest Zoologist collected further specimens from deodar trap-trees in the same locality in May 1911, and these were identified at the British Museum by Mr. C. J. Gahan as *Tetropium oreinum*, Gahan. The specimens obtained from the Simla Catchment Area in 1909 by Mr. Stebbing, from which the figures of the beetle, pupa, larva, etc., in Forest Memoirs, Zool. Series, Vol. II, i, Plate IV, were drawn and on which the life-history is based, were also submitted to Mr. Gahan and identified as *Tetropium oreinum*, Gahan. This was pointed out by Mr. Hole in Forest Bulletin No. 11, p. 21, but has been overlooked by Mr. Stebbing in his recent work.

The life-history of the Deodar Longicorn Beetle is reproduced without alteration from the Memoir on pages 340—344 of Indian Forest Insects with text figures 229, 230, 231 and Plate XXIV, under the species *Trinophyllum* (sic) *cribratum*, Bates, and a separate account is given on pages 284—285 of the species *Tetropium oreinum*, Gahan. From an examination of the specimens of these beetles in the Dehra Dun collection it is quite evident that the common Deodar Longicorn is *Tetropium oreinum*, Gahan.

If the data given under *Tetropium oreinum* on pages 284—285 of Indian Forest Insects are referable to this species, we are left with no information at all regarding the breeding habits of *Trinophylum cribratum*, Bates.

SYNONYMICAL REFERENCES.

Trinophylum cribratum, Bates, Forest Memoir, Zool. Series II, i, 1911, pp. 28—32, Plate IV, figs. 2, *a*, b_1, *b*, c_1, *c*, *d*, *e*, f_1, *f*, *g*, Plate VII.

Tetropium oreinum, Gahan, Forest Bulletin No. 10, 1912, pp. 20-21.

Tetropium oreinum, Indian Forest Insects, 1914, pp. 284-285, fig. 195.

Trinophyllum (sic) *cribratum*, Bates, Indian Forest Insects, 1914, pp. 5, 14, 33, 38, 61, 340—344.

SPHAEROTRYPES SIWALIKENSIS, STEBBING *(IPIDÆ)*.

Mr. Stebbing speaking of the restricted distribution of species of forest insects refers to those which breed in the *sal* as follows (loc. cit.), page 4 :—

"To quote one more instance among plains insects, a genus of bark beetles *Sphaerotrypes*, which infests the *sal* tree, has this local distribution. *S. siwalikensis* is found infesting the *sal* of the Siwaliks and United Provinces Terai. A second species *S. globulus* is found in the Central Provinces on the same tree; whilst a third species, *S. assamensis* infests the sal in Assam." Again on page 477 *S. siwalikensis* is referred to as "the bark-beetle pest *par excellence* of the sal forests of the United Provinces, and it probably extends into the sal areas in Nepal and to the east"; and on page 488 *S. globulus* is said to "infest the sal and *Terminalia tomentosa* of the Central Provinces and Chota Nagpur sal areas and take the place of the *S. siwalikensis* in the United Provinces and the *assamensis* in Assam."

The field-work which has been done since 1910 with these species indicates that their distribution is by no means so restricted as the lines quoted above would suggest. Specimens now in the collections identified by comparison with the type or by Colonel Winn-Sampson at the British Museum, show that *assamensis* is quite common in the Siwaliks and Terai, and in the Central Provinces and that *globulus* is common in Bengal and Assam. On the other hand, there is a single badly preserved specimen of *siwalikensis* in the collection, the type, and no others appear to have been added. I can find no difference between this specimen and immature males of *assamensis* while the topo-types have also been identified as *assamensis*. An examination of a long series of *Sphaerotrypes* from the United Provinces to Assam convinces me that there is only one species represented, and as *siwalikensis* is the prior name, *assamensis* must be sunk as a synonym.

SYNONYMICAL REFERENCES.

Sphaerotrypes siwalikensis, Stebbing, Depart. Notes, i, 1906, pp. 389—394, Plate XXIII, figs. 1, *1a*, *1b*, *1c*.

Sphaerotrypes siwalikensis. Stebbing, Forest Memoirs, Zool. Ser. I, i, 1908, p. 3.

Sphaerotrypes assamensis, Stebbing, Forest Bulletin No. 11, 1907, pp. 23—30, Plate V, figs. 5, 5*a—d*.

Sphaerotrypes assamensis, Stebbing, Forest Memoirs, Zool. Ser. I, *i*, 1908, p. 4.

Sphaerotrypes siwalikensis, Stebbing, Indian Forest Insects, 1914, pp. 476—481, figs. 314-315.

Sphaerotrypes assamensis, Stebbing, Indian Forest Insects, 1914, pp. 481—487, fig. 318.

XYLEBORUS SEMIGRANOSUS, BLANDFORD (*IPIDÆ*).

I have compared specimens of this species taken from *sal* in Bengal and the United Provinces and from mango in the United Provinces with the type of *Xyleborus bengalensis*, Stebbing, and find they agree. The specimens of *X. semigranosus*, Blandford, were collected in the same locality as Mr. Stebbing's species and have been identified as such by Colonel Winn-Sampson. *Xyleborus bengalensis*, Stebbing, becomes synonym of *Xyleborus semigranosus*, Bldfd.

SYNONYMICAL REFERENCES.

Xyleborus semigranosus, Blandford, Trans. Ent. Soc Lond., Part II, 1896, p. 211.

Dryocetes sp., Forest Bulletin No. 11, 1907, p. 38, Plate VI, fig. 4.

Dryocetes bengalensis, Stebbing, Forest Memoir, Zool. Ser. I., Part I, 1908, p. 12.

Xyleborus bengalensis, Stebbing, Indian Forest Insects, 1914, p. 590, Plate LX, fig. 3.

CROSSOTARSUS SAUNDERSI, CHAPIUS (*PLATYPODIDÆ*).

On pages 628—630 of Indian Forest Insects is an account of a platypodid which bores into *sundri* referred to under the name of *Diapus ? heritieræ*, Stebbing. There is no type or specimen of this beetle in the Dehra Dun collection, but Colonel

Winn-Sampson of the British Museum has informed me that he has examined some damaged specimens bearing the labels *Diapus heritieræ* which in his opinion are closely allied to *Crossotarsus saundersi*, Chap. I have recently obtained a series of this beetle from *sundri* (*Heritiera Fomes*, Buch.) and *singra* (*Cynometra ramiflora*, Linn.), in the type locality, which prove to be a small form of *Crossotarsus saundersi*, Chap., or possibly a local variety of it. There is no doubt that this is the species referred to by Mr. Stebbing as *Diapus heritieræ*, Steb.

SYNONYMICAL REFERENCES.

Crossotarsus saundersi, Chapius, Mongr. des. Plat., 1865, pp. 80-81, ♂ ♀ (lege ♀ ♂).

Diapus heritieræ, Stebbing, Departmental Notes, *i*, *1906*, pp. 420—422, Plate XXIV, fig. 5

Diapus heritieræ, Stebbing, Indian Forest Insects, 1914, pp. 628—630.

DIAPUS FURTIVUS, SAMPSON (*PLATYPODIDÆ*).

This small platypodid is one of the *sal* shot-hole borers and has proved recently to be of some importance in Bengal, where it is associated with the dying off of unhealthy *sal* trees.

From material collected in Assam in 1906, in the Central Provinces in 1909, and in Bengal in 1912, Colonel Winn-Sampson (Ann. Mag. Nat. Hist., Ser. 8, xii, 1913, pp. 450—452) described two new species of Platypodidæ, *Diapus furtivus* and *Diapus mirus*. The recent field-work carried out in 1913-1914 with *sal* pests in Buxa and Jalpaiguri Divisions, Bengal, shows that the two species are identical and that the sexes in each case have been wrongly interpreted. In the original description of *D. furtivus* the sexes should be reversed, and the description of *D. mirus* should be read as that of the female of *D. furtivus*. The difference between the two species is based on the presence in *D. mirus* of clusters of prominent-brush-like hairs on the front of the head between the eyes, and the absence of these in *D. furtivus*. Observations in the field show that the female beetle

on emergence from the *sal* tree in which it has developed possesses the frontal clusters and these are retained during migration but are gradually worn off in the process of boring the entrance gallery; female beetles taken from the egg-galleries in the sap-wood shortly after beetles of the new generation have paired, show no trace of the cluster of hairs. Specimens were sent to Colonel Winn-Sampson in December 1913, illustrating these points, and he has expressed his agreement that the sexes of *D. furtivus* should be reversed and *D. mirus* should become a synonym

SYNONYMICAL REFERENCES.

Diapus sp., Forest Bulletin, No. 11, 1907, p. 42; Plate VI, fig. 10.

Diapus furtivus, Sampson, ♀ ♂ (lege ♂ ♀); Ann. Mag. Nat. Hist., Ser. 8, XII, 1913, pp. -450-451.

Diapus mirus, Sampson (lege ♀), loc. cit., p. 452.

Diapus furtivus, Sampson, Indian Forest Insects, 1914, pp. 630—632, fig. 398 (lege ♂).

Diapus mirus, Sampson loc. cit., p. 633, fig. 399 (lege ♂).

EXTRACTS.

THE MATCH INDUSTRY.

The following account of the Samples Exhibition held at Lahore is from the *Civil and Military Gazette* :—

The existence of a very large market for matches in India is proved by the import figures quoted in a pamphlet on the subject issued by the Commercial Intelligence Department, and much attention has recently been directed to this industry in India. Japan is making a great effort to secure this trade : and last year five-twelfths of the total value of imported matches came from the country. Sweden has three-tenths of the import trade, Austria-Hungary had one-tenth, Norway about one-twelfth, and Germany and Belgium each had a small share. The total value of these imports last year was £597,000, which was £59,000 less than the previous year, the decrease in imports being brought about by the passing of the Indian White Phosphorous Matches Prohibition Act, an Act which is in force in most civilized countries to protect workers against the disease caused by white phosphorous fumes. The trade with Austria-Hungary, Germany and Belgium being discontinued through the war, and Japan experiencing difficulty in obtaining some of the necessary materials, an opportunity occurs for India to capture part of their trade. Several firms have exhibits in the Exhibition of Samples now open at Lahore, but the best display is that of the North India Timber Co., Ltd., of Bareilly, U. P., who send a neat sample case containing their popular brands of safety matches, the Dancing Girl, Squirrel, Padi-boat, Peacock and Match Stick On being tested it was found the matches were made of good wood which did not break when the match was struck, a common defect of cheap foreign matches, whereby the lighted head is apt to fly in one's face. There were no glowing ends. The boxes were well got up. These matches appeared to be quite a superior article to any others exhibited, whether of Indian or foreign manufacture, and an expert gave it as

his opinion that they were equal to the best made. The Bareilly Match factory is one of those which are demonstrating the possibility of making matches in India fully equal to the best imported matches, and there is reason to hope that in the match trade India will eventually be independent of foreign imports.—[*The Indian Agriculturist.*]

LEECHES IN MYSORE.

There are two kinds of leeches in the Ghat area of the Mysore State which attack men. One of these *Hæmadipsa* sp. (*H: Zeylanica ?*) shows the interesting feature of living on moist land, the other one, a much bigger form, living purely in fresh water. The following further particulars in addition to those given by Shipley (vide *Tropical Agriculturist,* February 1915, pages 119-120) with reference to the habits of the leeches and the methods used in escaping their grip may be interesting.

The leeches begin to appear in ordinary forest areas with the early monsoon, say, about the beginning of June, and molest the travellers till the end of December. There are certain very damp and woody places where they persist throughout the year. They occur on decomposing vegetation, fallen trunks of trees, leaves of shrub jungle, such as Strobilanthi, and even on bare rocks. They stand erect on one end, and perform mutating movements. The first few occasions that they bite, one is not aware of their presence, but habit makes one fairly cautious and a sort of cold uncanny feeling in the leg is a sure sign of the presence of a leech. It is not quite correct to talk of persons being killed by leech bites ; because, many hundreds of coolies work in the area day after day and yet survive the bite.

Among the measures employed in escaping their attack, smearing the legs up to the knee with castor-oil is a very effective one. Snuff, juice of sour limes, and slaked lime paste are also useful in getting rid of the leeches, especially the last, as it will stop the bleeding. If a man has passed through an area where leeches are known to exist, he will find it a useful practice to wash his legs in

warm water. He can thus see any leeches sticking on to his legs and remove them as soon as possible.

The leech cocoons are usually found on the ground in the jungle and sometimes collected and destroyed, but it is only to a very limited extent. The surest way to get rid of them is to put them in the fire.

Attempts to pull them off are not always the best as inflammation sets in. As noted above, a drop of acid juice makes them drop down, and if one has pulled out the leech and suppuration sets in, a bandage soaked in solution of lead acetate and tied over the swollen portion is a very useful remedy.—M. K. Venkata Rau, Mysore Agricultural Department.—[*Tropical Agriculturist.*]

HOW TIMBER IS FREQUENTLY DAMAGED.

Experiments at the Forest Service Laboratory of the Department of Agriculture have determined that the strength of a piece of wood may be seriously impaired by slight compression failures due to rough handling. Dropping a beam across a skid may cause a compression failure at the point at which the beam strikes the skid and it will be at this point that the beam gives way when it breaks under a strain too severe for the weakened fibres to withstand. Hitherto unaccountable breakage in hickory wagon spokes and other presumably strong materials are now attributed to compression failures caused by wind-storms in the period of growth or by hard usage in lumbering and manufacturing processes. These compression failures show themselves in the form of little diagonal streaks or wrinkles across the grain, and are always a sure sign of weakness.—[*Scientific American.*]

A SCHOOL OF FORESTRY IN CHINA.

It is notorious that afforestation is one of the most urgent of China's needs, and it is therefore of interest to learn that a School of Forestry is about to be established in the University of Nanking. The co-operation of the Director of Forestry at Manila has been secured, and it is proposed to send two experts from Manila to aid in establishing the school.—[*Scientific American.*]

THE VALUE OF MAHUA (*BASSIA LATIFOLIA*) AS A FOOD FOR THE POOR.

Over large stretches of country in Chota Nagpur and Bihar the gradual blossoming of the buds of the *mahua* flowers has been watched during the last few weeks with even more interest than usual. Owing to high prices of grains and to the smaller demand for labour in connection with the coal, mica and other industries, this jungle product is a very important addition to the food-supply of the poorer classes, while those who do not require it for their own consumption value it for their cattle. Even in prosperous times the gathering of the *mahua* flowers exercises a sort of fascination over the jungle tribes. A man, as the *mahua* begins to fall, will throw up a job on the railway or in the mines in order to join his family in gathering flowers of much less value in money than the wages surrendered, but it would seem a sort of sacrilege not to avail oneself of the bounty provided by nature for the poor. Some years ago a Forest Officer estimated that at the lowest valuation, in ordinary years, the *mahua* produce was worth to India not less than 35 lakhs of rupees, so that if this was capitalised at 15 years' purchase, it would mean that these trees are worth 5 millions sterling. There promises to be a good crop this year. There was no very cold weather to nip the buds, nor have there been severe storms to destroy them.—[*The Indian Agriculturist.*]

THE LOCAL EFFECT OF THE EUROPEAN WAR ON INSECT-LIFE.

So many vital matters depend upon the result of the conflict now being waged on the Continent that side issues are likely to be overlooked altogether. A correspondent of the *Field* calls attention to the local effect of the war upon insect-life, which he says must be a striking one, particularly in the areas in which battles are actually waged, and may possibly in the conclusion react unfavourably upon agriculture in England. He continues:—

Only in a few years will the full effect be seen. During the present year and with many species several years may elapse before any marked change in their numbers will be noticed ; but

that there will be a great difference will be evident from the following considerations.

One effect of the war will be a considerable increase in the amount of food available for certain insects. This particularly applies to species such as the burying and sexton beetles and blowflies, whose larvæ feed upon carrion. In these cases the generations usually succeed one another at short intervals so that myriads of these insects will be found before midsummer on all the battle districts of the Continent. The subject is not pleasant, but the rôle of the sarcophagous species is in reality a beneficent one, since they remove from the surface of the earth a considerable amount of decaying and pestilential matter.

Many insects which feed upon plants will likewise tend to increase in numbers, and this for several reasons. In the first place, there is withdrawn from the Forest Service of France, Austria, Russia, and especially of Germany, whose forests are particularly well cared for, a large body of men, one of whose duties is to keep in check the insect plagues which do so much damage to timber trees and consequently these will now have an excellent opportunity for regaining lost ground. Among these insects may be mentioned the processionary and gipsy moths, the various bark-feeding beetles such as the "Turk" (*Tomicus typographus*) and many species of Aphis. For a similar reason also there may be expected great increases in the numbers of insects which feed upon fruit trees, and it is not improbable that in Kent fruit-growers may suffer during the coming years from immigrant harmful insects such as the lackey moth, especially if easterly and south-easterly winds are at all common and strong during the season of their flight.

Again owing to the destruction of great tracts of woodland by artillery fire, and the impossibility of clearing away the dead timber, there will be an increase in lignivorous insects like the longicorn beetles, the goat moth, and the leopard moth. As many of these spend more than one year in the larval condition, the full effect of their increased food-supply will not be seen for some time.

Thirdly, owing to the failure to cultivate many of the fertile lands which are now lying waste, weeds especially annuals will rapidly cover them and thus the insects which partly keep them in check will speedily increase in numbers with consequent harmful effects in the countries where cultivation has continued without a check.

Finally, insectivorous birds, which very effectively reduce the ravages of many insects, have either been killed in the battle areas or have been driven completely away. The effect of this is obvious.

In some cases, however, it is just possible that the effect of the war may be a decrease in the numbers of some agricultural pests and this for the reason that with the cessation of agriculture in the ravaged districts there will be at least a diminution and possibly an annihilation of their food-supply, and consequently a reduced possibility of their larvæ reaching maturity.—[*Pioneer.*]

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THE JAND (*PROSOPIS SPICIGERA*) FORESTS OF THE PUNJAB.

BY B. O. COVENTRY, I.F.S.

I.—DISTRIBUTION AND AREA.

The **Jand** is a species of the alluvial plains and does not extend to the hilly regions, and may be found distributed over the whole of the plains region, south of the Salt Range, which is a low range of hills running from east to west through the Jhelum and Shahpur districts.

The forests existing at the present time are situated between the Salt Range and Sutlej river, and by far the largest areas are in the arid tracts with a rainfall of less than 10 inches, situated in the south-west corner towards the Indus river, in the Multan and Montgomery districts. In fact, almost the whole area of these districts consists of vast tracts of **Jand** forests.

The area of these forests, under the Forest Department at the present time, is about 3,500 square miles, of which there are about 2,700 square miles in the Multan Division, and about 700 square miles in the Montgomery Division, the remainder being in the Lahore, Gujranwala and Shahpur districts.

II.—ENVIRONMENT.

(*a*) *Climate.*

The climate of the plains region is one of intense heat in the hot weather months and of considerable cold with frosts of a few degrees at night in the cold weather. The hot weather commences about the 15th April and lasts until the 15th October. The hottest month is June when the average mean temperature for the month is 93° F. Maximum temperatures of 115° F. are frequent, and those of above this and up to 120° F. are not uncommon. Temperatures exceeding 120° F. have been recorded in Multan, Montgomery and Lahore. Hot, dry burning winds blow during May and June, and sand-storms are not uncommon and the air is usually laden with fine dust throughout the hot weather, except during the brief periods when rain falls.

The rainfall varies from about 5″ in the south-west corner near the Indus river to 30″ at the foot of the hills, decreasing steadily with distance from the hills as may be shown by the following figures for places more or less on a straight line drawn from the hills in a south-west direction to the Indus river :—

	Rainfall.	No. of rainy days.
Gurdaspur	34″	38
Amritsar	26″	32
Lahore	18″	26
Montgomery	10″	17
Multan	6·5″	12
Dera Ghazi Khan	5·8″	12

Most of the rain falls during the south-west monsoon in July and August. Winter rains also occur usually towards the end of December and in January. The most trying time for the vegetation is during the long drought with intense heat in May and June before the break of the monsoon rains.

(*b*) *Topography and Soil.*

The plains region of the Punjab is a vast flat plain of alluvial origin with a great depth of alluvial soil, entirely devoid of stones, except in the neighbourhood of the hills. The general slope is in a south-west direction from the hills to the Indus river. At the foot of the hills the elevation is approximately 2,000 feet, and the ground slopes away imperceptibly to about 300 feet at the south-west corner near the Indus river, giving an average gradient of about 4 feet in one mile. Almost the whole of the drainage flows into the Indus river being carried by the five rivers from which the Punjab derives its name (Panch = five, áb = water). The rivers rise in the heights of the Himalayas, being fed by the perpetual snows, and so are liable to high floods during the melting of the snows in the hot weather. Considerable tracts of country in the plains are thus subject to inundation by the rivers, and flood plains often in the form of islands (locally known as "belas") are formed by the deposit of silt as the floods subside. The high ground forming the watershed between two rivers is called locally the "bar" land. In the neighbourhood of the rivers the water-level may be not far below the surface but on the high "bar" lands, the water-level may be 100 feet below the surface. The following topographical features may thus be distinguished which have an influence in the distribution of the vegetation :—

(1) Newly-formed flood plains due to deposits of soil by flood waters.

(2) Low land subject to river inundation.

(3) Intermediate land above flood-level.

(4) High "bar" land with deep water-level.

The soil is usually a good fertile loamy soil which produces flourishing crops when supplied with sufficient water. In some localities a concretionary deposit of limestone, locally known as "kankar," which occurs in the form of a layer of a few inches in thickness at a few feet below the surface of the soil, is met with. Another peculiarity of the soil is that in some localities a white efflorescence is met with on the surface of the soil, which is due

to an excess of sodium salts in the soil. Soil of this kind is known locally as "Kallar" or "Reh" soil, and is infertile to most vegetation, and is also very impervious to water, so that after rain the water lies on it for a considerable time.

III.—DESCRIPTION OF THE FORESTS.

The **Jand** occurs gregariously over extensive tracts, but is more often associated with *Salvadora oleoides* (Wan) and *Capparis aphylla* (Karil). The forests are usually of an open nature with the trees sparsely scattered, and often with large blanks which may be due to a deposit of "Kankar" or to "Kallar" soil. On the lower ground when the water-level is at no great depth below the surface the **Jand** forms well-stocked gregarious forests, whereas on the high "bar" land the **Jand** is often absent and the ground is occupied by Wan and Karil either gregariously or associated together. The **Jand** thus gradually disappears with increase in the depth of the water-level. A peculiarity which is noticeable in some localities is that the trees are found growing on mounds which is due to the arresting by the vegetation of soil scooped up from the surrounding ground by the wind and deposited round the trees. In some such localities the trees have disappeared leaving the ground with the appearance of a grave-yard, each mound representing the position where a tree formerly stood.

Except for the tree-growth the soil is bare of other vegetation for several months in the year, but produces a fair crop of grass during the monsoon rains. The **Jand** forests yield small timber for the use of local villagers, but are chiefly of value for the production of firewood, and as browsing grounds for camels and goats, and as grazing grounds for horned cattle.

The forests are worked for firewood on the Coppice system with a rotation of thirty years. The yield in firewood varies very considerably according to the density of the crop, varying from about 100 cubic feet to 1,000 cubic feet stacked, per acre, the average being about 300 cubic feet stacked per acre.

IV.—Description of the Species.

(*a*) Jand (*Prosopis spicigera*).

The **Jand** grows to a medium-sized tree, rarely exceeding 30 to 40 feet in height or a girth of 4 feet. It is a light-demander and produces a light foliage, and is more or less leafless for a short period at the end of the cold weather. The new flush of leaves appears with the spring and the flowers appear in April to May, the fruits which are long, thin cylindrical pods ripening in October-November. A most important characteristic of the **Jand** tree is that it develops an exceedingly long tap-root which enables it to exist in these arid tracts of low rainfall by obtaining its water requirements from the permanent water-supply in the subsoil. Mr. Gamble, in his book on Indian Timbers, mentions a specimen now in the Kew Museum, which is 86 feet long and had penetrated to a vertical depth of 64 feet. The **Jand** develops root-suckers freely and also coppices well. In forests exposed to goat-browsing it is a common feature to find the stems of the **Jand** trees surrounded at their bases with a bush-like growth due to the constant browsing down of root-suckers.

Coppice shoots of **Jand** attain a height of about 30 feet in fifteen years with a girth of 2 to 3 feet in good localities.

The wood of the **Jand** is hard and affords excellent firewood and charcoal—a cubic foot of timber weighs about 50 to 60 lbs., and 100 cubic feet stacked weigh about 35 maunds or 2,800 lbs. Although the **Jand** does not produce large timber, yet it affords valuable timber for the use of the local villagers by whom it is utilised for many purposes.

(*b*) Wan (*Salvadora oleoides*).

The **Wan** (*Salvadora oleoides*) usually grows in the form of a large bush, due to the drooping nature of its branches which reach to the ground. It is evergreen and its leaves are thick and leathery. Its foliage is of a particularly vivid refreshing green colour in the hottest months. It does not grow to more than 20 feet in height, but its main stems may be as much as 6 feet

in girth. The area covered by a **Wan** bush may be as much as 30 feet in diameter, but on closer examination it will be found that this is due to a ring of root-suckers which have sprung up all round the parent stems and at some distance from it, the foliage of the root-suckers and parent tree coalescing to form one large rounded mass of even outlined foliage. In some cases the drooping branches from the main stem become rooted in the soil and a new stem arises forming a tree by means of natural layering. The **Wan** thus reproduces itself by root-suckers and layers and also coppices well.

The timber of the **Wan** is of little value, except as firewood, and as firewood it is of inferior quality. The leaves and twigs are valuable fodder for goats and camels.

(*c*) **Karil** (*Capparis aphylla*).

The **Karil** (*Capparis aphylla*) is a leafless species, producing a mass of drooping whip-like green twigs ending in a sharp point and growing in the form of a bush. It rarely attains more than 15 feet in height or a girth exceeding 2 feet. When in flower in April it is a beautiful object, being covered with a mass of red blossom. Its fruit is a round pink fleshy fruit readily eaten by birds. It produces root-suckers freely and coppices readily. The timber of the **Karil** is of no value except as a very inferior firewood.

V.—LIFE-HISTORY.

The most interesting feature about these forests is in connection with their origin and natural regeneration. It is possible to travel through hundreds of miles of these forests, and yet not find a single young seedling **Jand** plant. The usual explanations put forward to account for the absence of natural regeneration are that it is due to goat-browsing or a change in the climate. Neither of these explanations are however satisfactory, for in many of the forests in the Multan and Montgomery districts there is little goat-browsing, and as regards the climate there is no evidence whatever to show that the climate has changed within

any appreciable period of time. The probable explanation only occurred to the writer a few years ago on coming across a report on some forests in the Dera Ghazi Khan district, which stated that in some of the forests which are subjected to flooding from the rivers there was excellent reproduction of **Jand** from seed. The whole of the land occupied by the **Jand** forests is of alluvial origin, and consequently at some time or other has been subject to river inundation. It is reasonable to presume, therefore, that the **Jand** forests date their origin from the time when the soil on which they are now growing was subject to river inundation, and that the failure of natural regeneration from seed is due to the fact that the land has since been left high and dry with a deep water-level owing to the receding and lowering by erosion of the river-beds or, in other words, is due to a change in the water-content of the soil due to the lowering of the water-level.

There is every reason to suppose that large tracts of **Jand** forests have occupied the ground in which they now exist for hundreds, if not thousands, of years, in spite of the low rainfall, deep water-level and absence of natural regeneration from seed. That they have been able to do so is due to the development by the **Jand** tree of a very long tap-root which reaches the permanent water-supply in the subsoil and to the fact that the **Jand** reproduces itself by means of root-suckers. The **Jand** is thus adapted by the development of a long tap-root to meet the change in environment due to the lowering of the water-level which results from the gradual lowering of the river-beds by erosion; and although it is dependent on inundation of the soil for its natural regeneration from seed, when once established it is adapted by its powers of reproducing itself by means of root-suckers to maintain itself for an indefinite period on the same ground in spite of the change in the environment which leaves the land high above flood-level.

If the above explanation for the failure of natural regeneration from seed is correct, it is obvious that the regeneration of the forests either by natural regeneration from seed or by sowings cannot be expected, unless assisted by irrigation. This is

an interesting point, because from the fact that the **Jand** occurs so abundantly in these tracts of low rainfall, one might naturally assume that it is a species which could be utilised for afforestation work in other localities with similar climatic conditions, but it is evident from the above remarks that it could not be used for this purpose in such localities, unless aided by artificial watering.

All attempts to raise **Jand** from sowings in these arid tracts in the Punjab without artificial watering have failed. That it can, however, be successfully grown from seed in these arid tracts with the aid of irrigation has been proved by the formation of a plantation of this species, known as the "**Jand** extension" and which adjoins the Changa Manga plantation. The **Jand** extension was found about thirty years ago and is several hundred acres in extent, and is now quite a flourishing **Jand** forest.

The **Jand** forests afford an interesting example of how a species may be found occupying the ground, while at the same time the factors of environment are unsuitable for its natural regeneration from seed, owing to a change having taken place in the factors of environment (in this case the water-content of the soil) since the species originally came on to the ground.

It seems probable that at one time or other almost the whole of the plains region must have been covered with **Jand** forests, partly gregarious and partly associated with other species. With the increase of population resulting in extended cultivation of the soil, the forests have gradually been reduced in extent until they occupied only the more arid tracts, where climatic or other conditions were unfavourable for the cultivation of the soil. With the advent of canal irrigation all obstacles to the further extension of cultivation have been removed and within comparatively recent years large areas of forests have been given up and brought under cultivation. The flourishing colony of Lyallpur which was established about twenty years ago was at that time a semi-desert tract supporting **Jand** forests which with the aid of irrigation have been converted into cultivation. At the present time our irrigation scheme is already well advanced for bringing water to the

arid districts of Multan and Montgomery, and within the next few years an area of approximately two thousand square miles of **Jand** forests in these districts will be given up, and be converted into cultivation. The time in fact does not seem far distant, when probably the whole of the **Jand** forests in the Punjab will be wiped out of existence to be replaced by cultivation, and only isolated trees or small patches of **Jand** forests will be left scattered here and there as representatives of a species which formerly occurred as extensive forests covering the greater part of the vast alluvial plains. With the increase of population and ever-increasing demands for food-supplies it is inevitable that these forests should give way to cultivation, but at the same time it is necessary for the general welfare of the country that where possible there should be a fair proportion of forest land to cultivated land, and to partly compensate for the depletion of the Punjab plains of their natural forest land it has been wisely decided to retain an area of 50,000 acres for the formation of forests to be grown with the aid of irrigation.

TEAK FLOATING IN LOWER BURMA IN THE DRY WEATHER.

BY A. RODGER, I.F.S.

More than 100 miles north of Rangoon and some 15 miles east of the Rangoon-Prome Railway line, the Myaung stream flows out of the Pegu Yoma Hills. It has been utilised in past years as a floating stream for teak logs, but has proved unsatisfactory for that purpose, as its bed is narrow and winding and has become much blocked by snags and fallen trees, with the result that the logs have often been hung up and have formed troublesome jams, and have taken on occasion five or six years to find their way to Rangoon by water, instead of one or two. The forest is worked by Government Agency, and the local forest officers have during last season evolved an interesting method of using the little water there is during the dry weather to bring the logs out.

The first step is to clear the bed of snags, fallen trees, and accumulations of rubbish of all sorts. This work is most important,

and is now being undertaken on a considerable scale in Lower Burma. It is possible that if the beds of the streams had been kept clear every year for a number of years past by the contractors, a great deal of the present trouble in the lower reaches would not have arisen. The recent extensive flowering of bamboos has increased the likelihood of jams, as large quantities of dead culms find their way into the streams. These cause serious obstructions which can be easily destroyed by fire. In March and April fire may be very largely used for destroying accumulations of branches, roots, bamboos, coarse grass and weeds, and even fallen jungle-wood trees. After the rains a start is made by making a series of dams along the bed of the stream from two or four hundred yards apart. Above the uppermost of these dams some hundred logs or so are collected, and are arranged along the bed of the stream. The first and second dams are then built up and a long narrow lake is gradually formed above the upper dam by the slow accumulation of the water. The logs float in this and the water accumulates until some 4½ feet is the depth above the dam. At the point shown in the photograph (Plate 2) the breadth of the stream between its high banks is 30 feet, the height of the dam is 5-6 feet and the breadth across its top in the centre, 4 feet. Large semi-circular cuttings are made in the bank on each side to furnish the earth for the dam and round the outside edge of one of these is cut a narrow channel to carry off surplus water while the dam is being completed and the logs collected. Overflow is further provided for by half a dozen large bamboos which pierce the dam about one foot below its crest from the back to the front, and through these the water constantly runs. The front of the dam is held up by a slight fence of short poles and split bamboos. Two or three days are required to collect the water and bring the logs down close to the dam, and the second dam is finished during the same time. All being ready a hole is made in the centre of the upper dam and the water soon enlarges it. A dozen logs are waiting close above the dam, and these are allowed to go through as soon as the first rush is over. They pass through easily one by one, being guided by Burmese coolies with long poles, and

TEAK FLOATING IN LOWER BURMA IN THE DRY WEATHER.

Photo.-engraved & printed at the Photo.-Mechl. & Litho Dept., Thomason College, Roorkee.

Photo. by A. Rodger.

The dam ready to be broken.

TEAK FLOATING IN LOWER BURMA IN THE DRY WEATHER.

Photo.-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Photo. by A. Rodger

The dam after the first rush of water has subsided.

others are at the same time brought on from above. Hardly a dozen seem to go through with the rush of water, which is very soon held up by the lower dam, and the remainder of the logs are poled down from above as far as possible towards the lower dam in the water which is now forming a second lake deep enough to float them. The same process is then repeated between the second and third dams, and the logs are thus gradually brought out of the forest. If the number of logs in the upper reaches is large, the upper dam may be built up several times and the operations may go on until all the logs have been brought out, or the head of water becomes insufficient. This year, 1915, work will probably have to stop in the middle of March. An elephant is kept ready above the dam to push out the stranded logs and straighten those which float across the stream. The poling is all done by Burmans who are handy at this work, and the dams are made by gangs of Indian coolies, the Burman having no liking for the mamootie. Plate 2 shows the dam ready to be broken, and Plate 3 shows the same dam after the first rush of water has passed through it. No details are yet available with regard to the expense of this method of extraction compared to extraction by means of a tramway, cart-road, etc., but it is hoped that figures may be made available later.

IPS LONGIFOLIA, STEB., AS A PEST OF CHIR REGENERATION AREAS.

BY C. F. C. BEESON, I.F.S., FOREST ZOOLOGIST.

In his memoir on the insect pests of the **Chir** *Pinus longifolia*, Indian Forest Memoirs, Zool. Ser. II, ii, 1911, Mr. E. P. Stebbing says with reference to the habits of *Tomicus* [*Ips*] *longifolia*, the large bark-beetle of the **Chir** pine, that, "as far as present observations "show, this *Tomicus* only infests the *Pinus longifolia* in the pole "and older growth stages. I have not taken the insect in seedlings "or saplings, nor in the thinner branches of the crowns of larger "trees. The insect must be classed as one of the more dangerous

"of the pests of this tree. It only infests green trees, either newly "felled or blown-down ones, or sickly standing ones in the forest." These statements are reproduced in the account of the habits of this species given on page 559 of 'Indian Forest Insects," 1914.

A certain amount of work has been done recently with **Chir** pine pests, which makes it necessary to modify slightly the accounts previously published. The present paper deals only with the new aspect of *Ips longifolia* as a destructive pest on **Chir** regeneration areas.

From observations made by Dr. A. D. Imms, when Forest Zoologist in 1912, and by the writer in 1913—1915, it has been ascertained that seedlings and saplings are not immune from the attack of *Ips longifolia*, but that on the contrary the beetle is able to breed in perfectly healthy saplings and seedlings of all ages. The young pine are killed off rapidly and large patches of regeneration completely destroyed. We have therefore to modify the accepted opinion with regard to the sylvicultural importance of the beetle, and must class it as a serious pest of **Chir** pine reproduction. Whether the habit of attacking young pine growth is entirely new for this species, or whether it is a habit that has up till the present been overlooked or not recorded, is not evident.

A consideration of the recent bark-beetle attacks in Chakrata and Naini Tal Divisions suggests that the development of the habit is associated with the introduction of artificial conditions into the forest, and particularly conditions which result from heavy fellings in the neighbourhood of advance growth.

Course of the attack in 1912.

Tbe bark-beetle attack in Chakrata Division, U. P., was first reported in July 1912 by Mr. R. C. Milward, at that time Divisional Officer. Young **Chir** saplings and poles from 6 to 15 feet in height were found to be dying off in several places in Ninus Block of Bawar Range early in July.

Later in the same year further attacks were discovered in several localities in three other Ranges, *viz.*, Riknar Range, Utasna, compartment 1; Deota Range, leased forest, Charyanu, compartment 3, and Kalich, compartments 6 and 7; and Bawar Range,

Chilar, compartment 19, and Bostar, compartment 18. As a result of remedial measures suggested by Dr. Imms, who visited these localities, infested trees were cut out and burned in October, a band of living trees round each of the affected areas was similarly treated.

The attack was most severe in Utásna, compartment 1 of Riknar Range, where the entire crop of saplings and young growth was killed off in one large and five small groups.

The poles in the small patches averaged about 18 feet in height, but in the large group the growth was younger, with an average height of 10 feet, down to 6 feet. The largest tree killed on the area measured 25′ 6″, with a girth of 1′ 3″.

The area of the groups and the number of trees killed in each is as follows :—

Riknar Range, Utasna, C. I.

Group.			Area. Sq. ft.	No. of trees.
1	...	...	73×58	1,057
2	...	...	19×17	15
3	...	...	36×32	30
4	...	...	20×13	23
5	...	...	40×38	25
6	...	...	41×19	11
				Total ... 1,161

The dead and dying trees were cut out and burned on the spot. Similar measures were carried out in the other attacked areas in Bawar and Deota ranges before the close of the year.

Course of the attack in 1913.

In 1913 the attack of the bark-beetle was again observed in Utasna, compartment 1, whence it progressed into the neighbouring compartment. In Chilar, compartment 19 (Bawar Range), and in the next compartment Chilar, No. 6, there was considerable mortality amongst the younger regeneration.

No attacks were reported from the remaining infested areas of 1912.

The remedial measures were again carried out in the hot weather; the details of Utasna, compartments 1 and 2, are given below :—

Utasna, C. 1.			Utasna, C. 2.		
Group.	Area. Sq. feet.	No. of trees.	Group.	Area. Sq. feet.	No. of trees.
1 ...	16×25	14	1	27×20	30
2 ...	15×25	16	2	26×25	25
3 ...	18×25	20	3	37×25	30
4 ...	17×17	22	4	20×22	20
5 ...	12×17	19	5	42×56	155
6 ...	100×22	50	6	25×25	70
7 ...	50×25	35	7	19×16	85
8 ...	15×18	24	8	17×25	85
	Total ...	200	9	59×29	210
			10	20×25	90
			11	84×26	227
			12	13×16	65
			13	39×21	74
				Total ...	1,166

The trees killed were seedlings and saplings up to 20 feet in height, the majority being young advance growth of 4 to 5 feet height. In Utasna, compartment 1, the severity of the attack had considerably decreased and no further dying off occurred on the borders of the groups cleared and burned in the year before; the new attack was made in eight places in other parts of the compartment. The outbreak in compartment 2 resembled that which occurred in the adjoining compartment in the previous season.

In the three localities in Bawar Range, the attack does not appear to have been so severe and a smaller number of saplings were destroyed.

In Ninus, compartment 3, 429 **Chir** seedlings and saplings were cut out; in Chilar, compartment 6, the number removed was 300, and in Chilar, compartment 19, the number was 500.

Course of the attack in 1914.

The reports received from the Divisional Officer in 1914 indicated that the outbreak had practically ceased, and that no further activity was observable in the seriously infested areas of 1913. No progress appears to have been made in neighbouring localities and in only one area, in Bawar Range, Bana, compartment 20, were new points of attack encountered.

The destruction of dead and dying trees was carried out in all infested localities, and the outbreak was successfully controlled before the end of the rains.

In the same year, 1914, a small outbreak of similar nature occurred in **Chir** regeneration in Naini Tal Division, which was noticed by the writer early in June in Ninglat Range, Gagar, compartments 22 and 23. During June and July 515 dead and dying **Chir** seedlings and saplings under 10 feet in height were cut out of compartments 22, 23 and 26. The activity ceased as a result of the remedial measures adopted, and was not renewed in the following year.

In each of the centres of attack in the ten localities in Chakrata Division and in the three localities in Naini Tal Division, the species of bark-beetle to which the damage was due was found to be *Ips longifolia*, Stebbing. Usually the beetle worked alone, but occasionally two or three other species were found in association with it, viz., *Polygraphus longifolia*, Steb., *Platypus biformis*, Chap., and *Cryphalus major*, Steb., but in all instances as secondary infestations.

In all cases perfectly healthy trees in full vigour were attacked and killed off within a period of four to six weeks; seedlings 2 feet high succumbed naturally more rapidly than poles of 20 feet in height, but the attack of one generation was sufficient in the majority of individuals to cause death.

Origin of the attack.

In considering the reasons for this new habit of *Ips longifolia*,—which, if not unprecedented, has certainly not been displayed on a sufficiently large scale to cause comment—one's attention is at once drawn to the facts that the primary centres of infestation were in every case situated in or near a felling-area, and that the attacks commenced in the May or June following felling operations of the cold weather.

Moreover, the most severe attacks occurred where the felling operations were delayed or protracted into the hot weather or where considerable quantities of refuse tops and logs were left on the felling-area after removal of the timber. In Chakrata Division, where the **Chir** forests are worked under the Uniform system, the outbreak occurred in four Working Circles in the first Periodic Block, only in compartments under regeneration; attacks also occurred in two localities, which bounded on the first Periodic Block, and in which fellings were carried out. In Naini Tal Division the attacks occurred in compartments in which fellings were being made. From these facts it is clear that *the swarms of beetles which attacked the young growth were bred in the refuse branch-wood and logs of the felling-area.*

Development of the seasonal history.

Ips longifolia is a gregarious but not a social insect, and normally breeds in the weakened bast of the **Chir**. A felling-area acts as a centre of attraction to the emerging beetles of the over-wintered brood.

The winter brood develops in trees felled in October and November which are allowed to remain unbarked and unconverted till April of the next year. The emergence of the beetles of the first broods of the year occurs towards the end of March and early in April, dependant on the elevation and aspect of the locality and the daily maximum temperature. They concentrate on the felled timber which has accumulated during the cold weather months and particularly on those trees most recently felled. If the material remains unbarked, and unremoved until the end of May, the first generation is able to develop and the mature beetles

emerge. The emerging swarms of the second generation do not scatter but proceed to attack the living trees immediately adjoining the breeding centres. By concentrating on a small number of trees they are able to reduce more effectively their resistant power and prevent the copious resin flow which results from individual attacks. The resistance of seedlings and saplings is more easily overcome than that of poles and older trees, and in consequence it is found that the younger advance growth suffers heavily in the first attack.

The second generation is mature towards the end of July, and the beetles which emerge retain the gregarious instinct, and, provided the conditions remain favourable, proceed to establish the third generation *in loco*. The activity of the new broods results in an extension of the front of the infested areas, and fresh attacks at new centres.

The beetles of the third generation, if allowed to mature, issue at the end of September and in October and either migrate or found the hibernating generation.

The course of the seasonal history as outlined above represents the succession of generations resulting from the earliest broods which appear at the beginning of the activity of the species in the spring. If all broods of the over-wintering generation are taken into consideration and the influence of the locality factors also considered, it becomes evident that the succession of the generations is not definitely recognisable in the locality. Instead of a theoretical series of three well-marked swarm periods there occurs in actuality a more or less continuous emergence of beetles from the overlapping generations.

The unbroken activity after the first generation renders the adoption of remedial measures in the later stages of the attack somewhat more difficult.

Sylvicultural importance.

The large pine bark-beetle is classed by its discoverer (Stebbing, *loc. cit.* p. 559) as "one of the more dangerous of the pests of the tree," and he notes that "the attacks of such an insect are naturally the more to be feared in a pure than in a mixed forest."

To this, in view of the danger to young growth, may be added that its attacks are more likely to occur in forest managed under a system in which regeneration operations are concentrated. The regeneration areas in the first Periodic Block are in danger not only in the felling year, but also in preceding and subsequent years when neighbouring compartments are felled over. In the remaining blocks of Uniform forests, as also in Selection forests, attacks are unlikely, except where heavy fellings take place in the proximity of advance growth. In the former case, however, destruction of advance growth might be considered no loss.

Control method.

The remedial measures carried out in Jaunsar indicate that the pest can be controlled and its progress checked at any stage in the attack, but that it is a more simple and less costly procedure to adopt preventive measures.

The methods of control are based on the following principle, i.e., *the felling operations should be completed and the felling-area cleared before the beginning of April.* In cases where it is not possible to do so, the following rules should be observed :—

1. All trees felled and not removed by the 1st of April should be barked. The bark should be removed from the whole length of the bole and main branches and burned with the top and small wood.
2. All trees felled during April and subsequently which are not removed within one month of felling should be barked, and the bark burned with the tops and small branch-wood.
3. All refuse (branch-wood down to 12 inches girth) remaining on the felling-area after April, which is not removed within one month, should be burned.

In carrying out the above measures it may be noted that (1) by burning is understood a thorough charring of the bark, down to the wood, and (2) the object of barking the boles is to destroy the greatest number of broods possible for the time and labour involved ; so that if half the bark of three or four infested trees can be removed in the time that is occupied in removing all

the bark from one more difficultly-situated tree, the former is preferable.

As remedial measures the following rules should be observed:—

1. All dead, dying and freshly-attacked trees should be pulled up by the roots or cut out and burned at once.
2. Fresh attack in apparently healthy trees is indicated by small heaps of red bark dust in the bark-crevices, or at the base of the tree. Removal of a strip of bark will reveal the beetles egg-laying in their galleries.
3. The boundaries of the groups of attacked trees would be ascertained exactly; if this cannot be done with certainty a band 10 feet wide of living trees round the obviously dying group should be cut out and burned.
4. The area should be visited again a fortnight after the remedial measures have been carried out to ascertain if any groups have been overlooked.

In conclusion, I wish to add that I am indebted to Dr. Imms and Mr. Milward for the notes recorded on the course of the attack in Chakrata previous to 1913.

EXTRACTS.

AN INDIAN PAPER-MAKING FIBRE.

The following remarks by Mr. Burn, the Chief Secretary, at a recent meeting of the United Provinces Legislative Council, have been quoted extensively in the Indian press: "Some years ago a firm applied to this Government for a concession of the right to cut a certain kind of grass known locally as *ulla*. This grass had been experimented with at the Allahabad Exhibition by a pulping expert, and his report on it was extremely favourable. Some of the pulp which he produced from the grass was taken to England by a Forest Officer and shown to some manufacturers who use pulp

there, and was declared by them to be of as fine a quality as any other produced in any quarter of the world. A firm proposed to take a contract for extracting this particular grass, but it has withdrawn from the concession, because it has obtained one in a part of the country where operations are easier to conduct. His Honour is now prepared to take up the question of pioneering the extraction of pulp from that particular kind of grass, in the first instance as a State industry, and inquiries are now being made as to the plant which will be required and the cost. This also will be a very considerable industry in the Terai (at the foot of the Himalayas) and portions of Rohilkhand."—[*The World's Paper Trade Review.*]

A REMARKABLE TREE.

The London correspondent of the *Statesman* writes :—

The discovery of a new kind of wood possessing remarkable properties is reported in a French scientific journal. A specimen of this wood has recently been brought to France by a party of explorers from the region of Lake Chad, where the parent tree was found to have its home. The tree, which is known to the natives by the name **ambach** apparently belongs to the Mimosa family, and it is hoped to cultivate it in the south of France and in Algeria—wherever in fact the necessary conditions of warmth and humidity obtain. The **ambach** grows in abundance in the muddy river tracts of the Chad country, and with such rapidity that a few months suffice to cover vast regions of swamp with impenetrable forest. In a single season it attains a height of from 12 to 15 feet, the trunk during the same time expanding to a diameter of from 8 to 10 inches at its base. The leaves resemble those of the Mimosa, and the yellow flowers are large and irregular.

But the most remarkable property of the wood, and the one that is likely to give it a commercial value, is its extraordinary lightness. The specific gravity of dry cork varies from 2 to 24; that of **ambach**, on the other hand, according to the measurements of M. Sangle-Ferrieres, Assistant Director of the Municipal

Laboratory in Paris, is only ·1 when dry and 34 when completely impregnated with water. At the same time the texture of its fibres is so close that it can easily be cut into planks, and it has already been used for making tables and doors. The warlike tribes that live in the Chad region fashion shields from it ; strips of the material about one inch in thickness are bent and tied together with leather, forming a buckler which is proof against spears or arrows. Especially should this material prove useful for the making of life-belts and floats, and it is for the latter purpose that it is chiefly used by the inhabitants of the regions where it grows. When the Kouris, who inhabit the river tracts of that part of Africa, set out on a voyage, they fasten to their person a square beam of **ambach** from 6 to 8 feet long and about 8 inches thick, which enables them without difficulty to cross streams nearly a mile in width. With their bodies stretched along this rudimentary raft they paddle with their hands and feet, carrying their arms and clothes on their heads.

COMMERCIAL UTILISATION OF 'TARI' PODS.

Cæsalpinia digyna (or Tari pods) is a thorny, scandent shrub, found plentifully in a wild state in many parts of Burma and in Bengal and Assam. It occurs chiefly on level ground, especially on waste land near villages and in hedgerows, where the soil is of a sandy character. The plant avoids land which is saturated during the rains. When fully grown the shrub reaches a height of about 10 feet. The leaves are similar to those of the tamarind, but the pod is smaller, from 1¼ to 2 inches long, and from ⅝ to ¾ inch wide with thick margins. Each pod contains, as a rule, two nearly black pea-like seeds, between which the pod is constricted.

The value of *Cæsalpinia digyna* pods as a tanning material appears to have been discovered first in the year 1847. A short account of the experiments carried out at that period is given in the *Indian Agricultural Ledger* for 1899, No. 9. The question of the commercial utilisation of the pods appears, however, to have been left in abeyance for many years. From an article on the

subject in the *Bulletin of the Imperial Institute* we learn that in 1893 the Officiating Reporter on Economic Products at Calcutta instituted an inquiry into the matter, and arranged for the submission of three samples to the Imperial Institute for examination. A report which was furnished to the authorities in India on the results of this investigation is quoted in the *Agricultural Ledger* referred to above, and also in "Technical Reports and Scientific Papers" (Part I), published by the Imperial Institute in 1903. Two further samples were forwarded to the Imperial Institute in 1900, and the results of their examination are also given in the latter volume. A sixth sample was examined at the Imperial Institute in 1903.

The results of the examination at the Imperial Institute of the various samples are as follows (the analytical figures refer to the pod-cases freed from the seeds):—

Results of Analysis.

Sample.	Place of origin.	Moisture in material as received.	Tannin in dried material.	Total soluble matter in dried material.	Ash.
		Per cent.	Per cent.	Per cent.	Per cent.
1	Burma	11·07	53·82	69·7	2·28
2	Do.	10·93	53·86	70·4	3·76
3	Assam	11·4	59·89	74·2	1·84
4	Do.	13·72	45·45	64·4	2·30
5	Burma	13·17	59·5	82·6	2·10
6	Do.	10·8	54·5	73·0	2·78

From the above results it is clear that the pod-cases of Tari contain a high percentage of tannin. Technical trials which were arranged for by the Imperial Institute showed that the material was suitable for use by European tanners, and enquiries which were received after the publication of the first report indicated

that there would be a good market for the pod-cases if they could be exported from India in large and regular quantities. Under these circumstances the Indian authorities were asked to ascertain the quantity of Tari pods available for export. As a result of numerous enquiries instituted by the Forest Department the following estimates, which relate to the whole pods including the seeds, were obtained :—

(*a*) The Officiating Conservator of Forests at Maymyo, Burma, reported that it was estimated that some 10,000 lbs. of pods could be delivered by rail at Rangoon at Rs. 11 per 100 lbs., *i.e.*, about Rs. 240 (£16) per ton, and a further 6,000 lbs. or more could probably be delivered by river steamers at a similar price.

(*b*) The Divisional Forest Officer in the Minbu Division of Burma estimated that about 40,000 lbs. of the pods could be placed on the market at Rs. 75 (£5) per ton.

It will be seen that the above estimates are widely different. The enquiries indicated that the wild pods could only be collected in small quantities and at an excessive cost, and that consequently an export trade could only be established by cultivating the plant on a large scale.

A small quantity of about 600 lbs. of the whole pods was collected in 1908 by the Deputy Conservator of Forests at Pyinmana, Burma, and a sample was forwarded to the Imperial Institute. The sample was submitted to an English firm of tanners, who had expressed interest in *Cæsalpinia digyna*, and they offered to purchase the total quantity at the rate of £18 per ton in London. This was eventually agreed to by the Indian authorities who, however, stated that the whole pods could not be profitably exported at less than £22 per ton in London. The latter price, however, included a Government royalty of about £8 per ton.

The firm found the pods to be of excellent quality, and stated that if the price were reasonable they were prepared to buy up to as much as five tons weekly. They added that the commercial use of the pods would depend upon their price as compared with such materials as quebracho, myrabolans and sumach,

Quite recently an experimental consignment of the whole pods was sold in London at £14 per ton.

The experimental cultivation of Tari pods has been suggested by the Imperial Institute to the Indian authorities on various occasions, and the attention of Indian planters was called to the commercial value of the pods in the *Indian Trade Journal* of 29th December 1910, p. 356. It is therefore possible that regular supplies of the pods may now be available for export.

As practically all the tannin is contained in the pod-cases or husks, it would be necessary to separate the seeds and export the husks only. In some trials made on a small scale at the Imperial Institute, it was ascertained that the centrifugal palm nut cracker could be used for this purpose, but large scale trials are required before the machine can be definitely recommended. The seeds would afterwards have to be picked out by hand. In view of the fact that a very large quantity of seeds would be available if the pods were used commercially for tanning purposes, investigations have been made as to the possibility of utilising them.

The seeds are dark greenish-brown in colour, almost spherical, and average about 1 centimetre in diameter. They were found to consist of equal parts of kernels and shells. The kernels contain only about 26 per cent. of oil, or about 13 per cent. expressed on the whole seed, and it is very unlikely that the oil could be profitably extracted unless the seeds were obtainable at a very low price, especially as, owing to the hard nature of the shell, the residual "cake" would be unsuitable for use as a cattle food.—[*The Indian Trade Journal.*]

CACTUS (PRICKLY-PEAR TREE).

The cultivation of this tree, which in Cyprus is very much neglected, might, if improved, become a source of profit as it is, for instance, in Algeria, Tunis, Japan, South Italy, and Sicily where it is largely grown not only for fruit, but for fodder, as its broad leaves are an excellent food for milch cows and for pigs.

For instance in the capital of Sicily which has a population of 380,000 inhabitants, the consumption represents the respectable sum of £1,200—1,600 per day.

In Cyprus this plant thrives well everywhere, and it might well be grown not only as a fruit tree and forage plant, but also for fencing The method of cultivation is as follows :—

Prepare the ground thoroughly in the same way as for sowing cereals. Draw lines 5—6 metres apart along which holes should be dug 5 c.m. deep and 1½ metres distant from each other.

In January after cutting the leaves place them in the soil at an angle up to the half of their length. Before planting them, the leaves should be exposed to the sun for 2—3 days, because if some of the juice is not evaporated, they rot before striking root.

Once a year the plant should be manured, but the surface soil round the root should be kept hoed, care being taken not to injure the trunk. Two or three years after planting, some leaves should be cut from the middle or base of the tree in order to strengthen the trunk. The first fruit yielded should not be left on but should be knocked down with a light stick, taking care not to injure the leaves. This is done because the first fruits are very hard and full of seeds, whereas the subsequent ones are better, and have few seeds.

If the plant in question were cultivated and treated in this manner we should have choice fruit on the trees, even after November, and well packed fruit in store would keep till after December. Under such conditions the trees would yield fruit not only for local consumption, but also for export, and with comparatively small trouble or attention.—[M. Myrianthis in *The Cyprus Journal.*]

CINNAMON OIL.

The Chemist and Druggist (March 27th), referring to the antiseptic action of essential oils, makes special mention of Cinnamon oil, which is said to have proved "very efficient in preventing the growth of micro-organisms." It is suggested that soldiers at the front might be provided, for the instantaneous treatment of wounds, with collapsible tubes of ointment containing essential oil, such as Cinnamons which are more powerful than carbolic acid. It would of course be necessary to ascertain by clinical experience the limit of toleration of these ointments. It is stated that Eucalyptus oil does not interfere with the growth of micro-organisms.—[*Tropical Agriculturist.*]

TREES THAT KEEP WEATHER RECORDS.

In cutting up logs for experimental purposes at the Madison, Wis., laboratory of the U. S. Forest Service, it was noticed that in a number of them there were little diagonal streaks, or wrinkles, running across the grain, and that these appeared entirely on the same side of the trees. It was well known that these wrinkles indicated compression failures, such as result from too great a strain on the fibre at some time, either from bending in a storm or from rough handling; but as all of the logs in question came from the same locality in Florida, and the markings were all on the north side of the log, it was assumed that they were caused by some severe storm from the south that had swept over that part of the country. By carefully counting the annual rings of wood, and knowing when these trees were cut, it was decided that the storm recorded by the wrinkles must have occurred in the year 1898; and inquiries verified the fact that at that time a hurricane had swept over that region.—[*Scientific American.*]

THE PENCIL-MAKING INDUSTRY.

Extent of Foreign Competition.

No separate statistics can be given of the imports into India of pencils, as they are included in the general heading "Stationery, excluding paper." The value of imports under that head has risen progressively from £322,000 in the year ending 31st March 1910, to £467,000 in the year ending 31st March 1914. The imports in the latter year were mainly from the following countries :—United Kingdom, £332,000; Germany, £41,000; Austria-Hungary, £38,000 ; Japan, £20, 000 ; and the United States, £19,000.

Of the German and Austrian imports the most important are undoubtedly pencils. These countries are specially favoured in respect of the pencil-making industry on account of the presence of large deposits of amorphous graphite of a suitable quality and of a supply of excellent soft cedar wood. In both these respects India is at a disadvantage. The only part of India in which graphite has been worked is Travancore. The Travancore mines were worked for a number of years by an English firm on behalf of the Morgan Crucible Company of Battersea who took the whole output for their works. The Travancore graphite is flaky and suitable for the manufacture of crucibles, but it is doubtful whether it could be used for pencil manufacture, as it is difficult to grind to a fine powder. In any case the Travancore mines have been abandoned for the last two years, mainly, it is believed, because of the increased depth of mining and the decreased yield. Graphite of a similar character is known to exist in Tinnevelly, but has not been successfully worked as yet. Graphite schists are extensively developed also in the Chhattisgarh Feudatory States, notably in Kalahandi. Specimens sent to the Imperial Institute were unfavourably reported on largely owing to the fact that the graphite is not flaky and contains a fair percentage of deleterious matter. The material as it occurs would probably be unsuitable for pencil-making, but might be capable of treatment, of which the main essential is efficient washing. The material is ground and delivered on to vats through which water is kept flowing. The graphite floats and is caught after the siliceous and calcareous material has

sunk. Usually there are several vats arranged one below the other. When graphite occurs with mica, it is necessary to pass the powdered material over heated plates. This alters the physical constitution of the mica and allows it to sink with the other non-graphitic material. Otherwise the mica floats off with the graphite. The Geological Survey of India is in possession of specimens of the Kalahandi graphite and would be able to supply small quantities for experiment. Micaceous graphitic schists occur also near Lohardaga and Daltonganj. There are extensive deposits of graphite in Ceylon, but this is believed to be largely of the same class as the Travancore graphite, and it is not known whether it would be suitable for pencil manufacture. The pencil industry in India has therefore been compelled hitherto to import its graphite from Europe. The imported graphite is pure graphite which has already been treated to remove the silicates.

The second difficulty which confronts the Indian industry is the supply of suitable wood. No wood has yet been found of the same class as the soft cedar wood used in Germany and the United States, but the possibilities of Indian woods for pencil manufacture have not yet been fully exploited and the matter may still be said to be in the experimental stage. The Indian Forest Research Institute at Dehra Dun has considered this question on several occasions since 1908 and has had a number of promising woods tested by pencil-making firms. The latest conclusions at which they have arrived are that the best timber procurable in India, so far as has been ascertained up to the present, is *Juniperus macropoda*, which is found in the dry hills of Baluchistan. Another useful timber is *Cupressus torulosa* which is much more plentiful than the Juniper, but does not make up into so good a pencil, being somewhat tough. There are several other timbers which make up into low grade pencils, such as *Holarrhena antidysenterica*, *Wrightia tomentosa*, *Wrightia tinctoria*, *Podocarpus neriifolia* and *Cedrela serrata*. Further experiments are in progress at the present time with samples of wood brought from Southern India and Mysore, as enquiries recently made on the part of the Mysore Government showed that a quantity of soft wood suitable for pencil-making apparently exists in the Mysore forests.

There are at the present time a few small factories making pencil in India. The ordinary defects of the Indian pencil are that the wood is difficult to cut and the "lead" is too hard. They are scarcely of the same class as the better imported pencils which come largely from one or two firms, Messrs. Faber or Hardtmuth, of world-wide reputation. In the cheaper grades of pencil the Indian pencil manufacturer has now also to face Japanese competition. The Japanese pencils are the cheapest in the market, the prices ranging from 9*d.* to 1*s.* 4*d.* per gross, c. i. f. at Calcutta. Indian-made pencils of white wood, varnished, sell at about 1*s.* 2*d.* per gross at Calcutta.

The principal brands of German and Austrian pencils imported are the following :—

Austrian—

	Price.
1. Hardtmuth's "Kohinoor" Graphite ...	40*s.* per gross f.o.b. less 35 per cent.
2. Do. "Mephisto" do. ...	16*s.* per gross f.o.b. less 35 per cent.

The "Mephisto" brand being cheaper, has a larger sale than the "Kohinoor."

German—

	Price.
1. Johann Faber's No. 234 (soft, middling and hard).	3*s.* 2*d.* per gross f. o. b.
2. Johann Faber's Silver	3*s.* 4*d.* per gross f. o. b.
3. A. W. Faber's (soft, middling and hard)	5*s.* per gross less 25 per cent. and 10 per cent.
4. Ditto Train	3*s.* 1*d.* per gross f.o.b.
5. Ditto Taj Mahal	3*s.* 1*d.* per gross f.o.b.
6. Swan Brand (white wood, varnished) ...	1*s.* 9*d.* per gross c.i.f.
7. Ditto Cedar wood	3*s.* 6*d.* per gross c.i.f.
8. Moon Brand (white wood, varnished) ...	1*s.* 6*d.* per gross c.i.f.

The Swan Brand and Johann Faber's No. 234 are very popular, and are sold in large quantities.

Penholders in a great variety of descriptions are imported from Germany and Austria. The kind most in demand is J. W. Faber's No. 7765 in natural, red and black colours at 10*s.* 4*d.* per gross, less 35 per cent. A fairly large quantity of nickel pencil-protectors with clips is imported from Germany at 6*s.* per gross, less 25 per cent.

An industry of considerable promise in India is the manufacture of **chalk pencils.** The details of prices of Indian-made chalk pencils given below are those of a Punjab Company which recently started this industry. These chalk pencils have been very well reported on by the Director of Agriculture and Industries in the Punjab. The prices of the chalk pencils made by this Company are :—

White crayons—

Per case of 100 boxes each containing 144 sticks—Rs. 37-8 f.o.r. at any railway station in India.

Packed also in 25 and 50 gross cases for the convenience of schools at an extra charge of Re. 1-4 and Rs. 2-8 respectively.

Coloured crayons—

Per case of 100 gross boxes each containing 144 sticks—Rs. 50 f.o.r. at any railway station in India.

Retail packed in 12 gross boxes, Rs. 9 f.o.r.

Samples of these chalk pencils, together with other Indian-made pencils, are being exhibited at the Sample Exhibition at Commerce and Industry Buildings—1, Council House Street, Calcutta, which is now open to the public.—[*Indian Trade Journal.*]

Report of Chief of Bureau of Biological Survey, United States Department of Agriculture, Washington, for the fiscal year ended June 30th, 1914.

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ECONOMIC INVESTIGATIONS.

PRAIRIE DOGS IN NATIONAL FORESTS.

Campaigns for the extermination of prairie dogs in National Forests were conducted during the year in the Pike and Cochetopa Forests in Colorado, the Coconino Forest in Arizona, and the La Sal and Sevier Forests in Utah. In the two Colorado Forests work will be completed early in the present fiscal year. As a

result of the methods worked out by the bureau, prairie dogs have been completely exterminated over large areas where once they were common, and now only an occasional animal is seen in places where a year or two ago hundreds were in sight at one time. Following the destruction of a large portion of the prairie dogs by poison, predatory birds and animals exterminated those remaining.

Experiments were made in the Sevier Forest in May, when two days' work resulted in clearing large areas to such an extent that in a careful reconnaissance a week later no dogs were seen or heard where before they were very numerous.

A NOTE ON THE CULTIVATION OF *PODOPHYLLUM EMODI*

BY R. S. TROUP, I.F.S.

Attention has been drawn from time to time to the importance of the Indian Podophyllum (*P. Emodi*, Wall.,) owing to the fact that there is a higher percentage of podophyllotoxin in the resin of this plant than in that of the American species (*P. peltatum*). This note embodies the results of observations on the growth and development of the plant in Jaunsar, United Provinces, and of experiments in its cultivation in the same locality. These experiments were commenced by the writer in 1907, and as it was impossible personally to visit the plots with the frequency desirable, records of the progress of the experiments were maintained regularly by various officers of the Forest Research Institute and College whose duties took them to the spot; in this way observations were maintained with sufficient frequency. The officers who kindly assisted in this way were Messrs. Gibson, Rodger, Pearson, Marsden, Maitland-Kirwan, and Donald. So far the results of these experiments show that Podophyllum can be cultivated easily from seed or from pieces of rhizome, but owing to the very slow growth of the rhizomes it is by no means certain to what extent the plant can be cultivated with profit.

Locality.—In Jaunsar *Podophyllum Emodi* grows naturally between 7,000 and 9,500 feet on rich forest soil, often consisting of almost pure humus, in moderately shady to fairly open places, chiefly in forest of deodar, blue pine, spruce, silver fir, and moru, or kharshu oak (*Quercus dilatata* and *Q. semecarpifolia*).

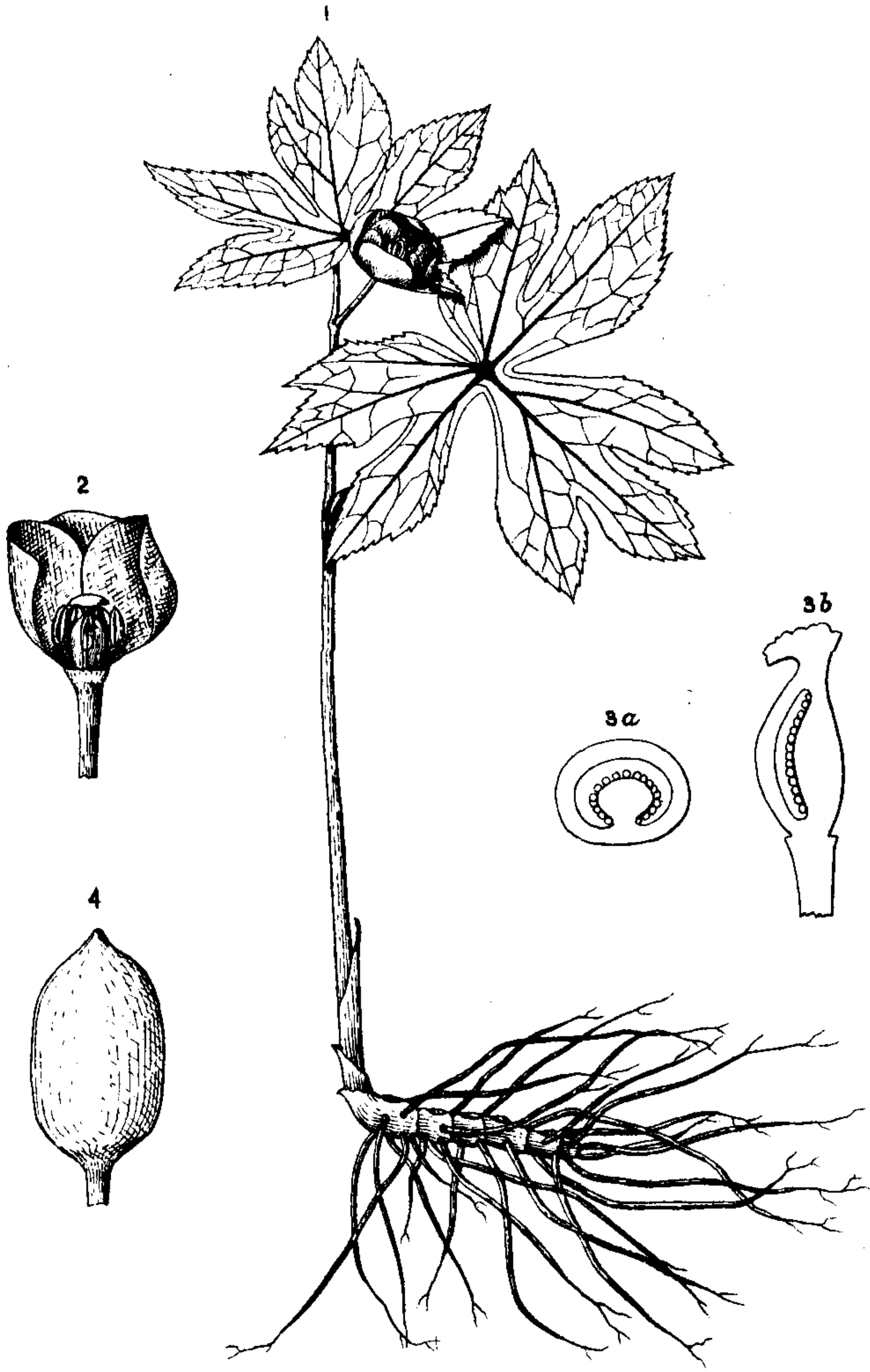
The plant (*vide* Plates 4 and 5).—A glabrous erect herbaceous plant, attaining a height of 2 feet or more in large specimens, with a perennial rhizome from which one or more stems are sent up

in the spring, dying down again in the autumn. The number of stems appears to vary with the age of the plant and the size of the rhizomes: generally speaking an average sized rhizome produces about 3 stems and a large rhizome about 5, a fact which is useful as indicating the size of plants suitable for collection for the market. Leaves solitary in young plants, 2 or 3 in fully developed plants, peltate, 3-partite with lobed segments. Flowers usually solitary, white or pale pink, 1-1½ in. diam. Fruit an ovoid berry 1½-2 in. long, scarlet when ripe: seeds numerous. Fl. end of April to beginning of June; fr. begins to form May, ripens July. The rhizomes and roots, from which the drug is obtained, constitute the part of the plant which is commercially valuable. The rhizomes vary in size with the age of the plant, attaining a maximum length of 6″ or more and a maximum diameter of 1″. The round scars of former annual stems are visible along the upper surface of the rhizome, like those of the "Solomon's seal." The roots are numerous, 5″—10″ long, yellow, tender and succulent, becoming very brittle on drying. The rhizomes are yellow on being cut open and both these and the roots are excessively bitter, with a fœtid odour. Podophyllum is subject to damage by grazing. The seeds are said to be eaten by birds and may possibly be spread by their agency.

Germination of seed and development of seedling (*vide* Plate 6).—In the natural habitat of the plant seed sown in July or August, immediately after ripening, does not normally germinate during the following year, but lies dormant through two winters, germinating in the spring of the second year and in some cases not till the third year after sowing. Seed sown in boxes at Dehra Dun (alt. 2,200 feet) in August commenced to germinate about 3 months after sowing, and germination continued for 7 months after sowing, *i.e.*, until March of the following year. This indicates that under abnormal temperature conditions germination is forced.

Germination is epigæous: the slender hypocotyl emerges ¼″ to 1″ above ground, carrying up the brown testa enveloping the cotyledons. The testa falls not long after emergence and the cotyledons expand: these are ovate elliptic obtuse, about ·25″

Podophyllum Emodi, WALL.



1. Complete flowering plant—$\frac{1}{3}$.
2. Flower $\frac{1}{1}$ [Caducous sepals not present].

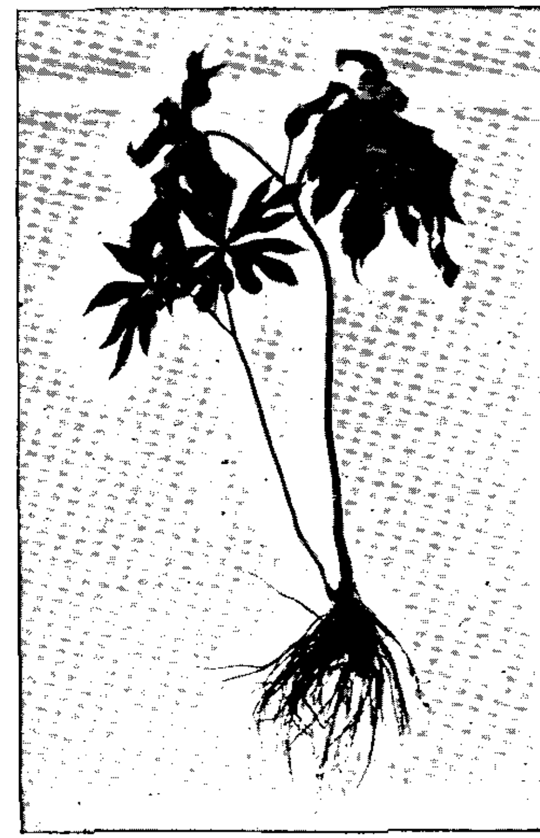
3a, 3b. Ovary $\frac{2}{1}$.

4. Fruit $\frac{1}{1}$.

PODOPHYLLUM EMODI, WALL.
Mature Plants.

Photo-engraved & printed at the Photo.-Mechl. & Litho Depth., Thomason College, Roorkee.

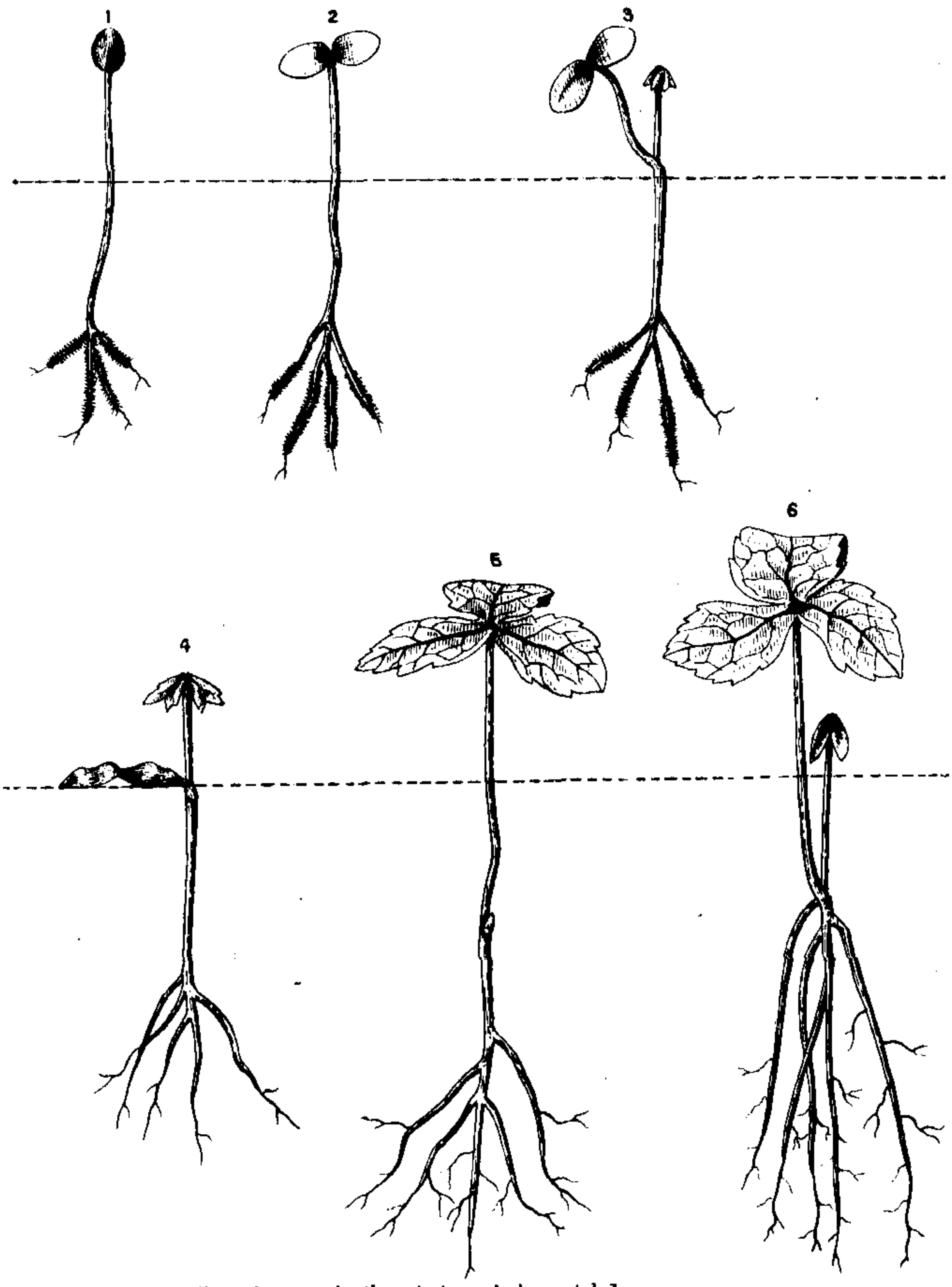
1. The plant in its natural home: fruiting specimen on right.



2. Fruiting specimen, showing root-system.

Podophyllum Emodi, WALL.

EARLY DEVELOPMENT OF SEEDLING.



1. Seedling after germination : testa enclosing cotyledons.
2. Cotyledons expanded.
3. Appearance of first foliage leaf.
4. Cotyledons dying off.
5. First foliage leaf expanded : bud of second foliage leaf formed underground.
6. Appearance of second foliage leaf.

[*Note.*—The horizontal dotted lines mark ground-level].

long, green, glabrous. The hypocotyl sheaths the stem of the first foliage leaf, which emerges not long after the expansion of the cotyledons; the latter soon die off, together with the hypocotyl. The first foliage leaf, like the leaves of mature plants, is 3-partite and peltate, attaining a diameter of 1 inch or less. A second shoot, bearing a single peltate leaf, appears in the first or second season of growth from a subterranean bud at the base of the original shoot. Some time after the emergence of the second shoot the original shoot dies down. This process is continued in the case of subsequent shoots, so that there may be one or two shoots present at one time.

Subsequent development.—The growth and development of plants raised from seed is extremely slow, as shown by observations at Bodyar (alt. 7,800 feet) where the progress of seedlings raised from seed sown in 1907 and 1908 has been carefully recorded up to 1914. These observations show that a vigorous root-system is produced at a fairly early stage, but the rhizome does not commence to form under 6 years from the date of sowing, and in the majority of cases does not show signs of forming even then. At this rate it is as yet too early to conjecture how long it will take to produce marketable rhizomes.

Cultivation from seed.—Attempts made at Dehra Dun to obtain rapid germination by soaking the seed for 8 days in water resulted in complete failure, none of the seed germinating after this treatment. Experimental cultivation from seed has been carried out, as stated, at Bodyar in 1907 and 1908. Freshly collected seed was dried, sown broad-cast in a prepared nursery bed and covered to various depths with earth. Germination took place mainly in the spring of the second year after sowing (*i.e.*, with two winters intervening) and in some cases not till the third year after sowing. The most vigorous plants were planted out in the forest in the spring of the third year after sowing (*i.e.*, plants one year old from time of germination). The smaller plants were pricked out in the nursery and kept there for varying periods up to the fifth year after sowing, and then transplanted. The transplanting was done in May, and gave no trouble, the plants surviving well: the beds

were under the moderate shade of deodar forest, the soil being well loosened and the beds prepared in terraces. Occasional weeding was carried out subsequently, but the beds were not kept regularly clean. In order to give room for development a spacing of at least 1 foot between plants is advisable. The development of the plants has already been described.

Cultivation from rhizomes.—Experiments in the cultivation of Podophyllum by planting rhizome sections have been in progress since 1907, partly at Kanjatra (about 8,500 feet) and partly at Bodyar (7,800 feet). In the former locality the plantations were made under moderate shade in spruce forest in prepared contour beds and in the latter they were made partly in open nursery beds and partly in prepared contour beds under moderate shade in deodar forest. Planting was carrird out in June and July, and subsequently in each case the beds were occasionally weeded, though not kept regularly clean.

In order to test the effect of planting rhizome sections of different lengths, the rhizomes were cut up into various lengths from 1 in. down to less than $\frac{1}{4}$ in. The different lengths were planted in different lines or beds, and the results were decidedly successful, the smallest sizes sending out roots and stems, and establishing themselves without difficulty. In some cases the smallest sizes produced the most vigorous plants and showed the strongest development of new rhizome, but on the whole the best results were obtained from sections of $\frac{1}{4}$ in. and over in length. The nursery plants were transplanted into beds in the forest, some 2 and some 3 years after the original planting of the rhizome cutting, and this operation proved quite successful. A comparison of the nursery-raised transplants with the plants raised from rhizome cuttings planted direct in the forest indicates that no object is gained in raising plants in the nursery, and if anything the transplanting tends to retard their growth.

As in the case of seedling plants, so in the case of plants from rhizome sections, the development of rhizomes is extremely slow. The rate of development varies with individual plants, but even in the most vigorous specimens there was no perceptible

growth of rhizome till the third year, while many plants had produced no visible rhizome even in 6 years. In the most favourable cases the maximum length of rhizome produced after 7 years was about $1\frac{1}{2}$ in., and this was exceptional; even after this period of time some of the plants had barely started to produce rhizomes.

Of the plants raised from rhizome cuttings some commenced to flower and fruit in the third year; in the same year a few plants produced two shoots, though the majority produced one shoot only.

It is thus too early to conjecture what period of time is required to produce marketable rhizomes of good size from plants raised from rhizome cuttings, but so far as these experiments go it is probable that the period will be found to be at least 12 years. So far the development of new rhizomes has proved to be more rapid in the case of plants raised from rhizome cuttings than of those raised from seed.

Summary.—The experiments in question have established the following facts :—

(1) that Podophyllum can be grown successfully either from seed or from sections of rhizomes of any size down to under $\frac{1}{4}$ in. in length, though perhaps this length should be taken as a minimum ;

(2) that in either case transplanting can be carried out without danger, though in the case of planting rhizome cuttings it is preferable to plant direct in the forest and not to transplant from nursery beds ;

(3) that the development of rhizomes is extremely slow : in the case of plants raised from rhizome cuttings it may possibly take at least 12 years to produce fair sized marketable rhizomes, while in the case of seedling plants the period is likely to be longer.

The plots will continue to be watched, with special reference to the development of the rhizomes.

It may be noted that nothing in the way of special cultivation or treatment of the soil has been carried out in these experiments : it is possible that this may stimulate the development of the rhizome, and if new experiments are undertaken special cultivation of the kind might be tried.

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THE NATURAL REPRODUCTION OF SAL AND HOW IT CAN BE IMPROVED.

BY R. S. HOLE, I.F.S.

Natural reproduction of Sal unsatisfactory.

1. The widespread death and "dying-back" of sal (*Shorea robusta*) seedlings is unhappily a familiar phenomenon to all those acquainted with our valuable sal forests in India. In these forests, reproduction is not infrequently entirely absent where it is urgently desired and elsewhere it is, as a rule, exceptional to find a sal seedling which has developed normally from the start and which has not died back for a number of years before developing the shoot which finally persists. This state of things is obviously very unsatisfactory, not only because it increases the liability of the plants to disease, caused by fungi entering *viâ* the damaged shoot and root, but also on account of the financial sacrifice involved in the loss of increment during a period of years and the obstruction to scientific methods of management caused by the uncertainty of reproduction.

Conditions affecting seedling development studied by Botanist.

2. With the object of discovering a remedy for this unsatisfactory state of affairs, the Forest Botanist was directed to study the causes of the dying-back of sal seedlings and to determine the conditions most favourable for successful germination and early development (*vide* Botanist's triennial programme for 1910—13). A number of experiments in connection with this work have therefore been carried out at Dehra Dun in the Experimental Garden and in the local forests during the last few years. Some of the experiments have already been described in detail in the *Forest Records* (Vol. V, Part IV, 1914), and the remainder will be published in the same way as soon as possible. Some months, however, must necessarily elapse before the remaining detailed papers appear in the *Records* and it therefore seems advisable to publish at once in the *Indian Forester* a brief abstract of the chief results obtained to date.

Bad soil-aeration and drought, the chief factors responsible for failure of Sal reproduction.

3. The work which has been carried out at Dehra Dun during the last few years has shown that, although sal seedlings in this locality have to face many dangers, such as wholesale destruction of the seed by porcupines, injury to the shoots and leaves by deer, insects and leaf fungi and damage to the root by insects, these factors are of minor importance.

Frost undoubtedly does great damage in open grasslands but apart from altogether exceptional seasons such as the cold weather of 1904-05, does very little damage in the sal forests themselves. On the other hand the two factors noted below have been found to be of outstanding and primary importance :—

(1) *An injurious soil factor* which comes into operation in the rainy season, especially in the months July and August. So far as is known at present, this factor can be effectually put out of action by sufficiently good soil-aeration and for the present it may be conveniently termed bad soil-aeration.

(2) Drought which causes widespread damage during the season of short rainfall from September to June

Of these factors, No. (1) is the most important, seeing that those plants which show vigorous and thoroughly healthy development throughout the rains are, as a rule, well able to withstand the subsequent danger of drought, owing to their strong deep-going root-system, whereas those plants quickly succumb which are weakly and have poorly developed roots at the close of the rains. It is, therefore, of the utmost importance to see that seedlings develop during the rainy season under conditions as nearly ideal as possible and this, as a rule, is all that is necessary for success.

Chief facts ascertained regarding bad soil-aeration.

4. As regards the soil factor No. (1), the work done up to date has not sufficed to define its precise nature or the exact way in which good aeration renders it inoperative. The chief facts ascertained regarding it are summarised below :—

(1) It has been proved that, in the local sal forest loam, the injurious factor suffices to kill or seriously damage 100 per cent. of sal seedlings when, through bad drainage, the soil near the roots contains a high percentage of water and a small volume of air-space, whereas in the same soil, when well drained, with less water and a larger air-space, the injurious factor is practically inoperative.

(2) It has been shown that, in one and the same type of soil, whereas the injurious factor has accounted for 95 to 99 per cent. of casualties among sal seedlings inside the shady sal forest, in two widely separate localities and during two consecutive seasons, it has had very little effect on the same soil in the open. The surface soil in the shade also has invariably contained a higher percentage of organic matter and water and a smaller volume of air-space than the same soil in the open.

(3) The injurious factor depends to a great extent on the presence of organic matter (especially dead sal leaves). Thus experiments have proved that its injurious effect can be greatly increased by mixing dead sal leaves with the surface soil, while, on the other hand, its

effect can be gradually neutralised by merely keeping the surface soil exposed to the air and clear of dead sal leaves.

(4) The injurious factor is inoperative in a well-drained sand containing 7 per cent. of calcium carbonate, even when dead sal leaves are mixed with the soil.

(5) Experiment has shown that the injurious factor may be operative in soil A and not in soil B, although both soils are of the same type (*i.e.*, the ordinary loam characteristic of the local sal forests) and the conditions of aeration slightly more favourable in A (as judged by the percentages of water and organic matter and the volume of air-space), provided that the surface of soil B has been kept clear of dead sal leaves and exposed to the air for a longer period than has that of soil A.

(6) Sal seedlings have been grown successfully, under artificial shades, in the loam of the Dehra Dun Experimental Garden which, during the rains, contained more water and less air-space than a similar soil in the local forests in which sal seedlings succumbed to the injurious factor. The garden loam, however, contained 2—3 per cent. less organic matter than the forest soil.

(7) The evidence at present available indicates that the injurious factor is not correlated with a deficiency of essential plant food, such as nitrates.

(8) Throughout the experimental cultures it has been repeatedly noticed that the injurious factor tends to assert itself during the rains, especially in the lowest parts of the seed-beds where water tends to accumulate and in those areas where the surface soil has formed a crust under the impact of heavy rain which interferes with the access of air and water into the soil; also that in different soils, other things equal (especially the content of organic matter), its effect tends to be most injurious in those which show the

slowest rate of surface percolation. With regard to this point, weeding during the rains is especially beneficial as it tends to break up the surface and improve the soil-aeration.

Bad aeration causes a deficiency of oxygen for root-respiration and probably also an accumulation of toxic substances.

5. None of the facts detailed in the last para. controvert the statement that the injurious factor can be rendered innocuous by sufficiently good soil-aeration. At the same time points serial Nos. 3, 5 and 6 clearly show that its existence, to a great extent, depends on the presence of organic matter. On the whole it seems probable that—

(1) the injurious action is due partly to lack of sufficient oxygen for root-respiration and partly to the existence of one or more toxic substances in the soil which are directly poisonous to the roots ;

(2) the toxic substance or substances possibly are, in part, excreted by the plant-roots themselves, or by some of the numerous soil organisms, but they are probably chiefly produced as a result of the decomposition of the organic matter in the soil ;

(3) the toxic substance or substances can only accumulate and become injurious under conditions of bad aeration coupled with a high water-content, whereas they are rapidly dissipated and rendered innocuous by good aeration. This point that the injurious factor is to a great extent only of a temporary nature is of considerable importance for it renders possible the rapid amelioration of an unsuitable soil and also accounts for the factor being especially injurious in the surface soil and less so in the subsoil. As water gradually percolates through the soil it becomes purified, partly by the filtering action of the soil and partly through the activity of bacteria which break down the complex and frequently poisonous organic compounds into more simple and harmless substances, and consequently

the water of a deep spring is usually pure and potable whereas surface water is relatively impure and frequently poisonous.

In the local sal forests during the rains, the shade of the trees effectually prevents rapid evaporation and the surface of the oil is covered with a sodden layer of dead sal leaves in which the rain-water tends to accumulate as in a sponge and also in the layer of soil immediately below the dead leaves. Observations have shown that, under these conditions, the surface soil in the local sal forests may contain 12 per cent. more water than the same soil situated a few yards away, in the open, outside the forest and without a covering of dead leaves. The more or less stagnant water held up in these spongy layers must naturally become impregnated with the substances produced from the decaying humus and it is easy to see that this water may be poisonous to the roots of sal, whereas the same water after percolating through the subsoil may become innocuous. In this way the roots of seedlings and the surface roots of large trees may be killed while the deeper roots remain healthy. It has been previously pointed out that this soil factor may be responsible for more or less extensive death and decay in the roots of sal plants which, above ground, appear quite healthy (see *Records*, V. 4, p. 39), and it is with respect to this partial injury that this factor may prove to be of special importance in preparing the way for the entry of parasitic soil fungi into the roots. It is not impossible that amelioration of this factor may prove the most practical means of combating such fungi which are notoriously extremely difficult to deal with and one of which has already been reported as damaging the sal forests of Bengal and Assam. Consequently, the accurate identification of this factor is a matter of practical importance and further experiments are now being carried out for this purpose by the Forest Botanist.

Remedies for bad sal reproduction.

6. Fortunately it is often possible to discover a practical remedy for a particular factor, the precise nature of which is not fully understood, and so far as the chief object of the present work is concerned, *viz*, the discovery of a remedy for the failure

of sal reproduction, the experiments already carried out have clearly shown that ideal development of sal seedlings, without dying back, can be secured in the local sal forests by clear-felling in strips or patches, combined with artificial sowing and weeding during the first rains. The work done has also shown that the ideal conditions for the development of sal seedlings on the loam characteristic of the local sal forests are :—

Clear-felling in strips and patches.

(1 A well aerated seed-bed free of raw humus.

(2) Full overhead light.

(3) Light side-shade sufficient to prevent damage from frost and to keep the soil as moist as possible during the season of short rainfall.

So far as can be seen at present, these conditions are best provided by the system of clear-felling in narrow strips and small patches. At the same time, the method which produces the best growth is not always the best sylviculturally. Thus, it is possible that the results obtained, excellent though they may be, do not yield a sufficient return to justify the high expenditure required, or the method may require more labour than is locally available. Such considerations may render clear-felling impossible except locally in limited areas. The experiments carried out, however, indicate an alternative method of aiding the establishment of reproduction, *viz.*, by the continued removal of humus and dead leaves by light leaf-fires or otherwise. In this way the number of sal seedlings on the ground can be materially and quickly increased. Their growth is decidedly inferior to that of seedlings established in the open, but it is probable that early removal or opening of the cover may soon remedy this defect. The determination of the best system to adopt, however, is a sylvicultural problem and a final decision will not be possible until the different systems have been tested by sylvicultural experiments on a sufficiently large scale to render possible a just appreciation of their comparative value, especially as regards their cost and final results. The object of the present work is merely to determine the factors which are chiefly responsible for

Removal of humus.

the death, disease and inferior growth of sal seedlings and to indicate the principal ways in which they can be controlled.

Protection of soil and admixture of humus usually beneficial but may cause temporary injury if prolonged.

7. The advocacy of soil exposure and firing as expedients to improve reproduction will no doubt strike many Forest Officers as being contrary to accepted principles regarding the generally beneficial effect on the soil of continued protection and additions of humus. No one who compares the loose moist loam in the protected sal forest with the dry, hard, dense soil of exposed areas in its immediate neighbourhood can doubt the great improvement effected by protection as regards the soil-texture and its moisture-content. Full recognition of this fact, however, is not inconsistent with the belief that long continued protection may result in an accumulation of humus and decomposition products which renders healthy growth impossible and that the injurious effects of long continued exposure and firing are not produced by temporary exposure and controlled firing for short periods.

Application of Dehra experiments to other forests.

8. The question now arises as to how far the results obtained by experiments in the Dehra Dun forests can be held to apply to other sal forests in different localities. In this connection it is believed that practically all our Indian sal forests can be placed in two main classes which may be conveniently termed Moist Sal and Dry Sal. In the former, the soil in the open is, as a rule, eminently suitable for sal as regards its texture and water-content but in the shady forest tends to become unsuitable on account of bad aeration and here the latter is, therefore, the factor of primary importance. The Dehra experiments have been carried out in rather inferior forests of this type, better examples of which are to be found in the moist sal forests of Bengal and Assam, but there is little doubt that the dominant factor in all these forests is soil-aeration.* As a general rule, the heavier the rainfall and the

* As regards the conditions prevailing in the sal forests of Bengal and Assam, see the extremely interesting *Note on the Forests of the Duars* by Mr. R. S. Troup, Sylviculturist, (published by the Government Central Press, Simla, 1915), p. 36.

moister the soil, the more injurious is this factor likely to be and the greater the benefit to be derived from clearings as extensive as possible, consistent with protection from frost.

On the other hand, in the Dry Sal areas a deficiency of soil-moisture leading to extensive damage by drought is the primary factor. Such forests may occur on light sandy soil and experiment has shown that, whereas bad aeration is not likely to be injurious in such a soil, continued protection and shade by increasing the soil moisture-content are almost certainly beneficial to sal reproduction. Forests which must be included in this type also occur on loam and these have, as a rule, suffered more or less severely from fires and grazing in the past. Such forests are usually open, with little or no undergrowth but grass, and the soil is dense and hard. The rainfall here tends to run off the surface instead of percolating into the soil and carries away with it most of the humus and organic débris. In such cases, simple protection is frequently of little use as the gradual thinning of the overhead cover and death of the old trees slowly but surely renders the soil drier and more and more unsuitable for seedling growth, while clear-felling and further exposure of the soil would clearly only make matters worse.

Two methods of treatment are here possible :—

(1) Introducing an underwood as a soil protection. This would in time convert the forest into one of the moist type in which sal reproduction could be secured as recommended above by temporary exposure on strips and patches.

(2) Preventing the run-off of rain-water and encouraging its percolation into the soil by surface cultivation, trenching or small embankments. If necessary this should be accompanied by surface cultivation or mulching in the dry season to diminish the loss of moisture from the soil by evaporation.

Forests of this type are seen in the Jaspur forests of the United Provinces and in some of the inferior sal forests of the Central Provinces, *e.g.*, those on the east of the Jubbulpore District.

There is thus reason to believe that the results of the Dehra experiments are likely to be of value in other sal forests in different localities.

Value of grasses as indicators of soil-conditions.

9. From what has been said above, it will be seen that the management of any particular sal forest to a great extent depends on the fact whether the seedlings in it suffer chiefly from drought or bad soil-aeration and therefore the determination of this point is of primary importance.

Observations regarding the season when the seedlings chiefly die and the dryness of the soil at the time naturally indicate to a great extent which factor is primarily concerned. In addition to this, however, the Dehra experiments have shown that the dominant grasses on an area are, as a rule, excellent indicators of the soil-conditions. Thus in N. India where *Saccharum Narenga* and *Anthistiria gigantea* subsp. *arundinacea* tend to be dominant the soil-moisture and aeration are, as a rule, suitable for the best development of sal and sal forests of the moist type prevail. In shady forests in such localities the seedlings suffer chiefly from bad soil-aeration and the most efficient remedy consists in opening the cover and exposing the soil. On the other hand such grasses as *Saccharum Munja*, *Saccharum spontaneum*, *Eragrostis cynosuroides*, *Imperata arundinacea*, *Vetiveria zizanioides*, *Andropogon contortus* and *Ischæmum angustifolium* indicate a soil too dry or too dense for the best sal development and such forests as occur are of the dry sal type. On sandy soil, in such cases, the soil-moisture can be improved by maintaining a close cover and increasing the admixture of humus in the soil. On loam, on the other hand, improvement must aim at—

(1) improving the texture and moisture of the soil by increasing the admixture of humus in it;

(2) preventing the run-off of rain-water and encouraging its percolation *in situ* into the soil on which it falls;

(3) preventing excessive loss of moisture from the soil by evaporation in the dry season.

These objects can be secured by the introduction of an underwood, by soil-cultivation, trenching, small embankments and mulching. The recognition of the dominant grasses in the sal tracts, therefore, is a matter of considerable practical importance.

A NOTE ON THE CULTIVATION OF *PODOPHYLLUM EMODI*

BY R. S. TROUP, I.F.S.

Attention has been drawn from time to time to the importance of the Indian Podophyllum (*P. Emodi*, Wall.,) owing to the fact that there is a higher percentage of podophyllotoxin in the resin of this plant than in that of the American species (*P. peltatum*). This note embodies the results of observations on the growth and development of the plant in Jaunsar, United Provinces, and of experiments in its cultivation in the same locality. These experiments were commenced by the writer in 1907, and as it was impossible personally to visit the plots with the frequency desirable, records of the progress of the experiments were maintained regularly by various officers of the Forest Research Institute and College whose duties took them to the spot; in this way observations were maintained with sufficient frequency. The officers who kindly assisted in this way were Messrs. Gibson, Rodger, Pearson, Marsden, Maitland-Kirwan, and Donald. So far the results of these experiments show that Podophyllum can be cultivated easily from seed or from pieces of rhizome, but owing to the very slow growth of the rhizomes it is by no means certain to what extent the plant can be cultivated with profit.

Locality.—In Jaunsar *Podophyllum Emodi* grows naturally between 7,000 and 9,500 feet on rich forest soil, often consisting of almost pure humus, in moderately shady to fairly open places, chiefly in forest of deodar, blue pine, spruce, silver fir, and moru, or kharshu oak (*Quercus dilatata* and *Q. semecarpifolia*).

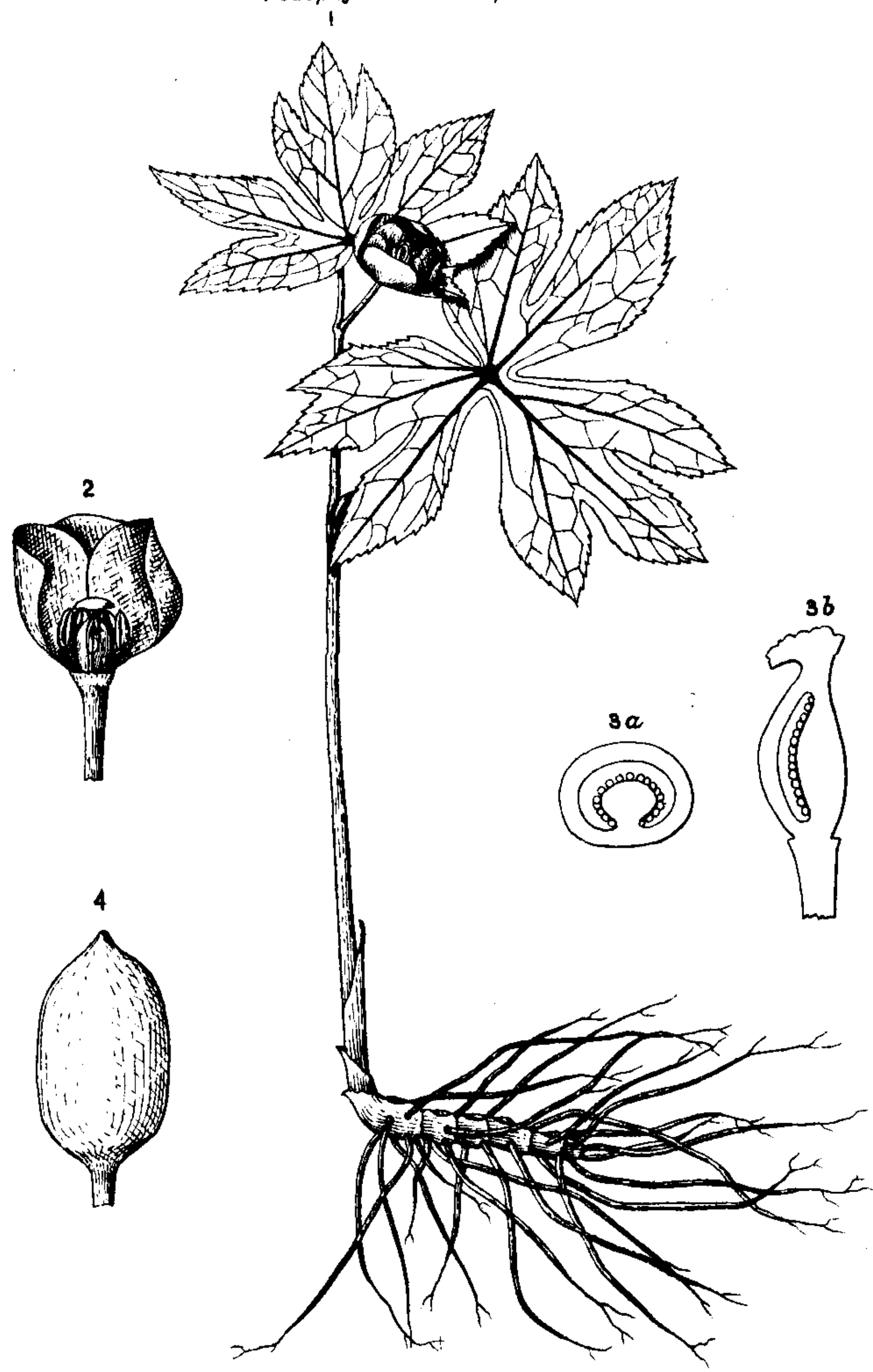
The plant (*vide* Plates 4 and 5).—A glabrous erect herbaceous plant, attaining a height of 2 feet or more in large specimens, with a perennial rhizome from which one or more stems are sent up

in the spring, dying down again in the autumn. The number of stems appears to vary with the age of the plant and the size of the rhizomes: generally speaking an average sized rhizome produces about 3 stems and a large rhizome about 5, a fact which is useful as indicating the size of plants suitable for collection for the market. Leaves solitary in young plants, 2 or 3 in fully developed plants, peltate, 3-partite with lobed segments. Flowers usually solitary, white or pale pink, 1-1½ in. diam. Fruit an ovoid berry 1½-2 in. long, scarlet when ripe: seeds numerous. Fl. end of April to beginning of June; fr. begins to form May, ripens July. The rhizomes and roots, from which the drug is obtained, constitute the part of the plant which is commercially valuable. The rhizomes vary in size with the age of the plant, attaining a maximum length of 6″ or more and a maximum diameter of 1″. The round scars of former annual stems are visible along the upper surface of the rhizome, like those of the "Solomon's seal." The roots are numerous, 5″—10″ long, yellow, tender and succulent, becoming very brittle on drying. The rhizomes are yellow on being cut open and both these and the roots are excessively bitter, with a fœtid odour. Podophyllum is subject to damage by grazing. The seeds are said to be eaten by birds and may possibly be spread by their agency.

Germination of seed and development of seedling (*vide* Plate 6).—In the natural habitat of the plant seed sown in July or August, immediately after ripening, does not normally germinate during the following year, but lies dormant through two winters, germinating in the spring of the second year and in some cases not till the third year after sowing. Seed sown in boxes at Dehra Dun (alt. 2,200 feet) in August commenced to germinate about 3 months after sowing, and germination continued for 7 months after sowing, *i.e.*, until March of the following year. This indicates that under abnormal temperature conditions germination is forced.

Germination is epigæous: the slender hypocotyl emerges ¼″ to 1″ above ground, carrying up the brown testa enveloping the cotyledons. The testa falls not long after emergence and the cotyledons expand: these are ovate elliptic obtuse, about ·25″

Podophyllum Emodi, WALL.



1. Complete flowering plant—½.
2. Flower ½ [Caducous sepals not present].

3a, 3b. Ovary ½.

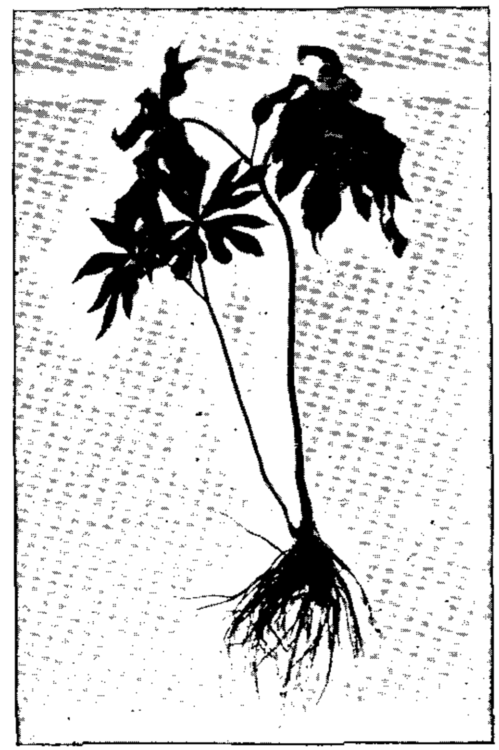
4. Fruit ½.

PODOPHYLLUM EMODI, WALL.

Mature Plants.

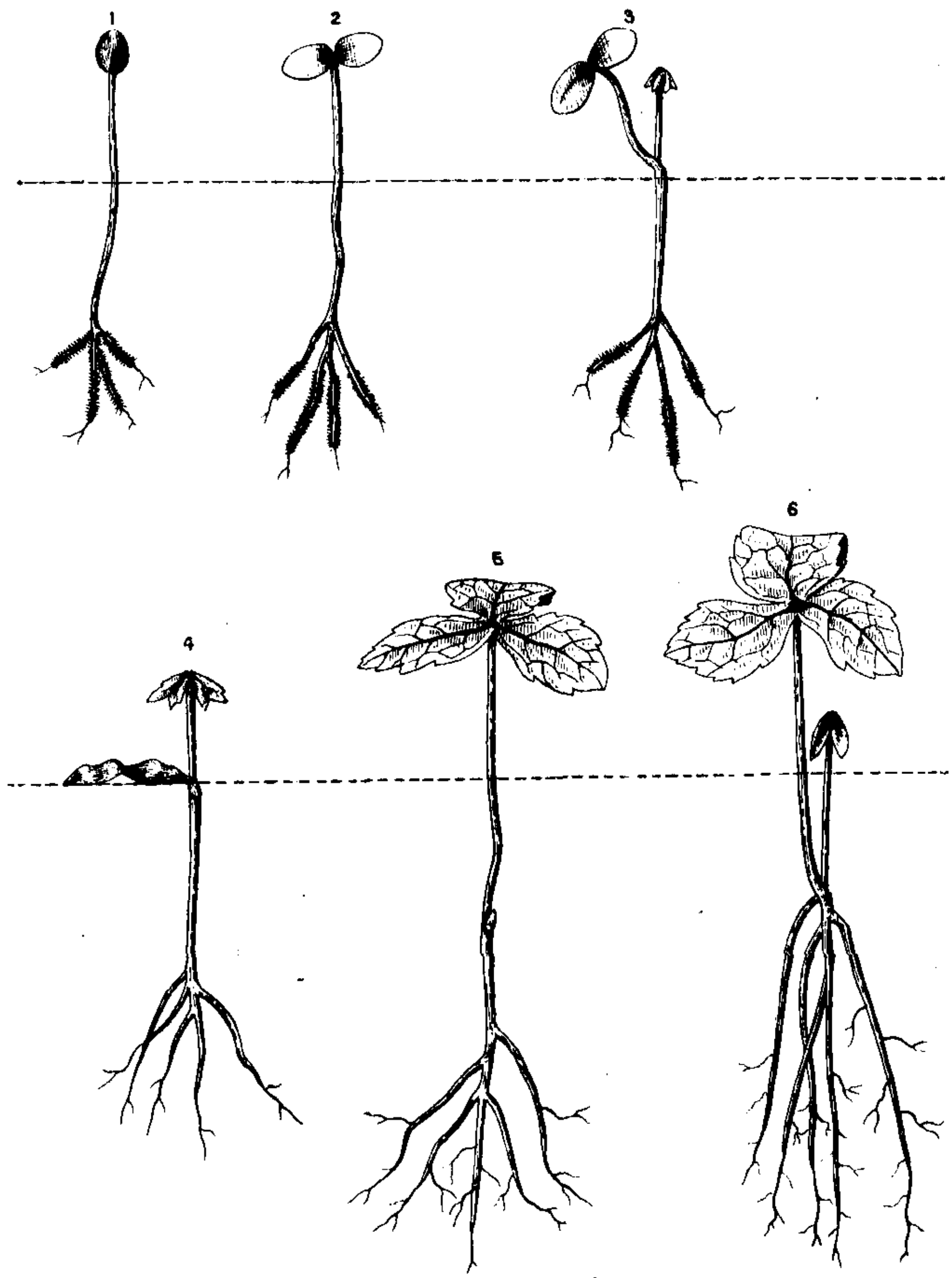
Photo-engraved & printed at the Photo.-Mechl. & Litho Depth., Thomason College, Roorkee.

1. The plant in its natural home: fruiting specimen on right.



2. Fruiting specimen, showing root-system.

Podophyllum Emodi, WALL.
EARLY DEVELOPMENT OF SEEDLING.



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long, green, glabrous. The hypocotyl sheaths the stem of the first foliage leaf, which emerges not long after the expansion of the cotyledons ; the latter soon die off, together with the hypocotyl. The first foliage leaf, like the leaves of mature plants, is 3-partite and peltate, attaining a diameter of 1 inch or less. A second shoot, bearing a single peltate leaf, appears in the first or second season of growth from a subterranean bud at the base of the original shoot. Some time after the emergence of the second shoot the original shoot dies down. This process is continued in the case of subsequent shoots, so that there may be one or two shoots present at one time.

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Cultivation from seed.—Attempts made at Dehra Dun to obtain rapid germination by soaking the seed for 8 days in water resulted in complete failure, none of the seed germinating after this treatment. Experimental cultivation from seed has been carried out, as stated, at Bodyar in 1907 and 1908. Freshly collected seed was dried, sown broad-cast in a prepared nursery bed and covered to various depths with earth. Germination took place mainly in the spring of the second year after sowing (*i.e.*, with two winters intervening) and in some cases not till the third year after sowing. The most vigorous plants were planted out in the forest in the spring of the third year after sowing (*i.e.*, plants one year old from time of germination). The smaller plants were pricked out in the nursery and kept there for varying periods up to the fifth year after sowing, and then transplanted. The transplanting was done in May, and gave no trouble, the plants surviving well : the beds

were under the moderate shade of deodar forest, the soil being well loosened and the beds prepared in terraces. Occasional weeding was carried out subsequently, but the beds were not kept regularly clean. In order to give room for development a spacing of at least 1 foot between plants is advisable. The development of the plants has already been described.

Cultivation from rhizomes.—Experiments in the cultivation of Podophyllum by planting rhizome sections have been in progress since 1907, partly at Kanjatra (about 8,500 feet) and partly at Bodyar (7,800 feet). In the former locality the plantations were made under moderate shade in spruce forest in prepared contour beds and in the latter they were made partly in open nursery beds and partly in prepared contour beds under moderate shade in deodar forest. Planting was carrird out in June and July, and subsequently in each case the beds were occasionally weeded, though not kept regularly clean.

In order to test the effect of planting rhizome sections of different lengths, the rhizomes were cut up into various lengths from 1 in. down to less than $\frac{1}{4}$ in. The different lengths were planted in different lines or beds, and the results were decidedly successful, the smallest sizes sending out roots and stems, and establishing themselves without difficulty. In some cases the smallest sizes produced the most vigorous plants and showed the strongest development of new rhizome, but on the whole the best results were obtained from sections of $\frac{1}{4}$ in. and over in length. The nursery plants were transplanted into beds in the forest, some 2 and some 3 years after the original planting of the rhizome cutting, and this operation proved quite successful. A comparison of the nursery-raised transplants with the plants raised from rhizome cuttings planted direct in the forest indicates that no object is gained in raising plants in the nursery, and if anything the transplanting tends to retard their growth.

As in the case of seedling plants, so in the case of plants from rhizome sections, the development of rhizomes is extremely slow. The rate of development varies with individual plants, but even in the most vigorous specimens there was no perceptible

growth of rhizome till the third year, while many plants had produced no visible rhizome even in 6 years. In the most favourable cases the maximum length of rhizome produced after 7 years was about $1\frac{1}{2}$ in., and this was exceptional; even after this period of time some of the plants had barely started to produce rhizomes.

Of the plants raised from rhizome cuttings some commenced to flower and fruit in the third year; in the same year a few plants produced two shoots, though the majority produced one shoot only.

It is thus too early to conjecture what period of time is required to produce marketable rhizomes of good size from plants raised from rhizome cuttings, but so far as these experiments go it is probable that the period will be found to be at least 12 years. So far the development of new rhizomes has proved to be more rapid in the case of plants raised from rhizome cuttings than of those raised from seed.

Summary.—The experiments in question have established the following facts:—

(1) that Podophyllum can be grown successfully either from seed or from sections of rhizomes of any size down to under $\frac{1}{4}$ in. in length, though perhaps this length should be taken as a minimum;

(2) that in either case transplanting can be carried out without danger, though in the case of planting rhizome cuttings it is preferable to plant direct in the forest and not to transplant from nursery beds;

(3) that the development of rhizomes is extremely slow: in the case of plants raised from rhizome cuttings it may possibly take at least 12 years to produce fair sized marketable rhizomes, while in the case of seedling plants the period is likely to be longer.

The plots will continue to be watched, with special reference to the development of the rhizomes.

It may be noted that nothing in the way of special cultivation or treatment of the soil has been carried out in these experiments: it is possible that this may stimulate the development of the rhizome, and if new experiments are undertaken special cultivation of the kind might be tried.

THE UNIFORM SYSTEM IN BURMA.

BY H. R. BLANFORD, I.F.S.

1. In the *Indian Forester* for April there is an article under the above heading by Mr. Walker in which he accuses the majority of Burma Forest Officers of blindly taking up the idea of the Uniform system for teak without considering the possible results of such a change of system. I do not know on what grounds Mr. Walker has suddenly been taken with the idea that we are all converted to the Uniform system, but I am certainly not in favour of its immediate adoption nor do I understand that most other Forest Officers in Burma have that idea. My idea of the present policy of the Department with regard to this question is in agreement with the resolutions of the Forest Conference. These were—

(1) that Improvement fellings to be useful must be concentrated and repeated ;

(2) that in this way only will it be possible to work over the whole area of suitable forests with required intensity once in the course of a rotation ;

(3) that this method while entailing little sacrifice of immature stems such as would be necessary by the immediate adoption of the Uniform system may eventually lead to the formation of a series of even-aged gradations at the end of the first rotation. I would ask Mr. Walker to peruse the Working-plan for the Mosit Reserve, Bhamo Division, which was written shortly after the Conference of 1911 and embodies proposals of the Conference. This is not the Uniform system, though admittedly the Uniform system may be found more suitable for carrying on the management of the forest after the end of the first rotation, *i.e.*, say 150 years hence.

At that far distant time what will become of Mr. Walker's objections to the Uniform system ?

His chief objections are—

(1) reduction of yield previous to end of first rotation ;

(2) that it would be impossible to regenerate by artificial and natural means the area necessary to form even-aged crops over $\frac{1}{100}$ of the area available ;

(3) that concentration of fellings necessary will only increase the danger of anthrax.

In view of the fact that Mr. Walker has entirely misrepresented the whole question and that immediate adoption of the Uniform system is not contemplated, save in one or two isolated exceptions, most of his objections are groundless. I will deal with them serially. It may however be pointed out here that wherever forest management has been carried on for any long period, whatever the species, light-demanders or shade-bearers, the Selection method originally necessary since all virgin forests are uneven-aged, has given place to some type of the Uniform system. The one exception is in such forests where the constant maintenance of cover and forest growth necessitates the Selection method. It is all very well to say we are too much inclined to imitate blindly what they do in Germany in forest policy, but the fact remains that nowhere where forests have been worked for any period on a financial basis has the Selection method survived.

2. I will now deal with Mr. Walker's objections to the Uniform system.

(1) *Reduction of yield previous to end of first rotation.*—This objection is entirely due to Mr. Walker's mistaken idea that immediate adoption of the Uniform system is contemplated. Concentrated improved fellings do not in any way contemplate sacrifice of immature stems. A slight sacrifice of stems which have attained marketable dimensions is occasionally contemplated, but this will take place in only one block each period and will in no way affect the number of trees to be girdled towards the end of the rotation. The only difference it will make would be in the slight diminution of the yield in each block during the period following that in which concentrated Improvement fellings have been carried out in that block. I recommend Mr. Walker's attention to Mr. Cubitt's suggestions on page 3 of the Proceedings of Burma Forest Conference of 1911, where this is very clearly shown.

(2) *Impossibility of regenerating by artificial and natural means the area necessary to form even-aged crops*.—This objection is best considered in the light of details of work actually carried out now. I will take Katha Division of which I am at present in charge. This Division has some 803 sq. miles of reserved forests but a large proportion is non-teak bearing and unsuitable for the adoption of any detailed method of working in the interests of teak. At a very outside estimate 450 sq. miles are suitable for application of detailed working-plans in the interests mainly of teak.

Assuming a rotation of 150 years it will therefore be necessary to undertake 3 sq. miles of primary Improvement fellings yearly besides carrying on repeated Improvement fellings in areas on which primary Improvement fellings have already been carried out. During the last three years the following gives the average annual area on which heavy Improvement fellings have been carried out showing the cost per acre.

Primary	Improvement fellings	4,441	acres, cost	Re. 1-7-0	per acre.
Secondary	do.	3,494	do.	0-2-0	do.
Supplementary	do.	3,531	do.	0-5-0	do.

[NOTE.—*Primary* are the first heavy Improvement fellings.]

Secondary are carried out in the rains following the Primary and consist in cutting out superfluous teak stool-shoots, cutting creepers and occasionally clearing and tending any fresh regeneration where this is not already sufficient.

Supplementary are carried out repeatedly when necessary in areas on which Primary and Secondary have already been done. From above the cost of Primary, Secondary and two Supplementary Improvement fellings may be taken at Rs. 2-3-0 per acre. Besides this in the present year planting and artificial regeneration is being carried out over a further area of some 100 acres which may well represent areas in the annual Improvement felling area in which it is found necessary to regenerate artificially.

From this it will be seen that it is perfectly possible to work up to the method even with the small and untrained staff at our disposal. A most important point is *to give up the idea that*

Improvement felling can only be done by gazetted officers and to train our subordinates to do the work. An attempt at this has been made in this Division.

It is not claimed that the work done is faultless but that with increased and better trained staff and smaller charges the undertaking of the work necessary is possible over a considerably larger area than is required under the scheme of concentrated and repeated Improvement fellings. This may be all very well but is the regeneration produced and established sufficient to give a yield at one felling equal to the whole yield obtained on the area throughout the rotation under the Selection system ? Under the Selection system girdlings are done every 30 years, *i.e.*, five times in the rotation (I am taking the same case as Mr. Walker has already done of a rotation of 150 years divided into five periods of 30 years each). The regeneration established must therefore be sufficient to give at maturity five times the yield at present given in one period under Selection method. A good class Selection forest yields one tree per acre on the average in the first period. It is therefore necessary to establish sufficient regeneration to give five mature trees per acre in addition to the older trees that will give the yield during remaining periods of the first rotation under the Selection system. Herein is the weak point of the whole system. We have not yet any data to say whether this is possible or not. In the natural forest where no assistance has been given to regeneration of poles and saplings nature is capable of producing one mature tree per acre from seedlings originating within a period of 30 years. Our task will be by means of Improvement fellings to assist nature to such an extent that that yield is multiplied by at least five. When it is considered that that help not only consists in furthering regeneration but in helping to establish and continue to protect for several years existing and new teak plants the establishment of the necessary crop of young teak appears to be well within the limits of possibility. This question requires very careful research at an early date.

(3) *That concentration of fellings necessary will only increase the danger of anthrax.*—Mr. Walker's objection to the Uniform

system on the ground that concentrated fellings encourage the spread of anthrax appears to be very sound if the Uniform system was to be adopted immediately, but this can never be a lasting objection. It is due entirely to our ignorance of the maladies of elephants and the backwardness of any scientific investigation into the subject. Further the employment of elephants and buffaloes is bound in time to give way largely to mechanical means, and it surely cannot be long before lessees are compelled to abandon their present disregard of all mechanical means on account of the very high price of and difficulty in obtaining working elephants. Surely it is not too much to hope for that in 150 years mechanical means of extraction will be far more if not entirely in use and that, if any elephant extraction is carried on at all, at least some method of inoculation against anthrax will have been discovered as it has already been discovered in most diseases that have been the subject of prolonged scientific research. Moreover the concentration of working possible under the Uniform system will entirely favour mechanical extraction.

3. The above arguments may possibly correct the impression that immediate adoption of the Uniform system is the aim of most Burma Forest Officers but no one pretends to be blind to the fact that eventually the present method of working will in all probability lead to a state of affairs which may necessitate the adoption of the Uniform system. Will Mr. Walker please notice that up to now no reference has been made to the Mohnyin working circle. I may well lay claim to have more experience of that forest than most people, but I should never dream of adopting the system on which that forest is being managed in other forests in Burma at the present time except as an experiment in isolated areas. The utility of the Mohnyin experiment (for it is certainly no more) is that it gives us a demonstration of the working of the Uniform system. At present the results are that natural regeneration can be obtained but that the cost is very great. Further experiments are now being made to reduce the cost and results obtained should form a useful basis for working out a system of management in other areas 150 years or so hence, should it then

be decided to introduce the Uniform system. Even then the comparative scarcity of bamboos in Mohnyin must make this area different from most others. The chief difficulty in the introduction of the Uniform system after 150 years would appear to be the difficulty of obtaining natural regeneration in certain types of bamboo forests. Experiments in regeneration in bamboo forest are an important part of our research programme and every opportunity should be taken to observe and record results of bamboo flowering. Without in any way endangering the future of our forests we can continue concentration of Improvement felling and experiment on the eventual method to be adopted for teak. It is far too early to say definitely what system will eventually be found most suitable, but at any rate the present system provides for a suitable concentration of the work it is possible to undertake while not binding us down in any way to a change of system. In conclusion it is only necessary to point out that if Mr. Walker's ideas of Improvement felling are really such as he describes them in his article I should strongly recommend him to read the latest proposed standing orders on the subject. His description of them as "thinning in uneven-aged mixed forest" may apply to the new "O" fellings but certainly do not apply to "Y" fellings* in which measures for natural regeneration and maintenance of the same are prescribed. The average cost verified from administration reports is absolutely useless as a basis to go on as at present few Improvement fellings are being done of the necessary intensity and area and the cost of the cheaper Secondary and Supplementary Improvement fellings are included. I have already shown above the cost of Improvement fellings in this Division in which some attempt to follow the resolutions of the Conference has been made.

* We understand that "O" fellings are Improvement fellings carried out to help the older trees and "Y" fellings those which are designed to help the younger trees.—HON. ED.

THE MYODWIN TEAK PLANTATIONS, ZIGÔN DIVISION, LOWER BURMA.

BY A. RODGER, I.F.S.

Some 10 miles east of Zigôn, 117 miles from Rangoon on the Prome Railway line, lies the small Myodwin Reserve, containing some of the oldest teak plantations in Burma. The forest is entirely surrounded by paddy fields and temporary cultivation and is about 3 miles distant from the forests of the foot hills of the Pegu Yoma. The soil is a good loam and the rainfall is abundant, so that there is in places in the unplanted parts of the Reserve a thick growth of creepers and fast growing shrubs. In this area it was decided in 1862 to plant teak, and the work appears to have begun under the direction of Sir Dietrich Brandis himself, as the remains of his office can still be traced.

The late Mr. Slade noted that Myodwin was originally the head-quarters of the Forest Department in Burma. The first plantation of 1862 was formed by sowing seed in lines 6 feet apart that of 1863 by transplanting seedlings from nurseries, the plants being put out 3 feet by 10 feet, and that of 1864 by sowings made 3 feet apart in lines 10 feet apart. The work was done by Red Karen coolies who were employed on blasting work to clear floating streams in the Pegu Yoma during the dry weather. From a note, dated "Forest Office, Myodwin, March 5th, 1864," the cost of the plantation of 1864, 1·75 acres in area, was as follows:—

	Rs.
Clearing jungle	18
Preparing ground	68
Sowing	7
Transplanting	2
Weeding	40
Fencing	9
Total ...	144

"The area was covered with low tree jungle which was cut and burnt, and the large trees were dragged away. The ground was well broken and turned up with mamooties and small drills thrown up."

In 1866 Mr. F. W. Harper sent in a report on the plantations to Mr. James Adam Leen, Assistant Conservator of Forests, who forwarded it to Mr. H. Leeds, Conservator of Forests. He gave the areas as follows :—

			Ac.	roods.	poles.
Plantation of	1862	... ...	0	2	32
Do.	1863	... ...	0	1	20
Do.	1863	... ...	1	2	33
Do.	1864	... ...	1	3	20
Do.	1864	... ...	3	1	28

And his notes indicate that the plantations were on the whole well stocked with healthy plants.

The plantations with 30 acres of surrounding forest were made into a reserve in 1875.

The whole plantation was thinned in 1867 and 1868 and again in 1876, but no record is given of the number of stems cut. It is noted in 1880 that the cover was complete throughout, there was no undergrowth and the trees were healthy in appearance. The counting of a small plot 100 feet by 125 feet in the 1863 plantation in 1880 gave 130 trees with an average girth of 20 inches, that is 453 trees per acre.

In 1895 about half the total area was lightly thinned, but the trees were girdled and not felled, and during the following years they fell in various directions, and did a good deal of damage. In 1898 a heavy thinning was made by the Divisional Forest Officer. It is evident that this thinning was too long delayed, and Mr. Corbett notes in 1898: "The stems are straight and long and free from side branches but taper very much owing, no doubt, to the trees being drawn up, unnaturally, by the dense shade due to the want of earlier thinnings: the crowns are very small." Mr. Corebtt measured the height of 13 dominant trees left standing and found that the average was 98 feet. The old

plantations were again thinned in January and February 1909, the average number of trees per acre removed being 30.

From 1868 to 1882 the area was successfully protected from fire, with the exception of the year 1878. Up to 1882 formation (including weedings and early thinnings) had cost Rs. 431 and fire-protection Rs. 541. In 1885-86 some new plantations were made and the cost of fire-protection from that date consequently includes the whole area. In January 1888 the first permanent sample plots were laid out, comprising :—

A. ·5 acre in plantation of 1863, thinned by Messrs. Popert and Carter in December 1885.

B. ·289 acre in plantation of 1864.

The following figures are available for these plots :—

Year of counting.	Plot A, ·5			Plot B, ·289 acre.		
	Age.	No of trees.	No. of trees per acre.	Age.	No. of trees.	No. of trees per acre.
1880 ...	...	...	...	16	130	449
1888 ...	25	157	314	24	118	408
1889 ...	26	153	306	...	...	...
1894 ...	31	154	308	30	120	415
1895 ...	32	157	314	31	74	256
1896 ...	33	156	312	32	71	245
1897 ...	34	155	310	33	70	242
1903 ...	40	69	138	39	38	131
1904 ...	41	69	138	40	38	131
1909 ...	46	45	90	45	26	89
1911 ...	48	45	90	47	26	89
1912 ...	49	45	90	48	25	86

It will be noticed from the way in which the numbers increase and decrease at first that the stems were evidently carelessly counted when the plantations were young.

Photo-engraved & printed at the Photo.-Mechl. & Litho Dept., Thomason College, Roorkee.

MYODWIN TEAK PLANTATION, BURMA.

In 1915 a plot measuring ·536 acre was laid out by the writer in the plantation of 1864, and the photograph (Plate No. 7) shows the appearance of the trees in this plot. The number of trees was 49 (that is, 91 per acre), and of these 25 were dominant, 11 dominated and 13 suppressed. We have, therefore, 91 trees per acre at 51 years of age.

The 49 trees on the sample plot fall into the following classes :—

Girth.					No. of trees.
1′ to 1′ 11″	...	...	...	...	2
2′ to 2′ 11″	...	...	...	...	10
3′ to 3′ 11″	...	...	...	...	12
4′ to 4′ 11″	...	...	...	...	16
5′ to 5′ 11″	...	...	...	...	5
6′ to 6′ 11″	...	...	...	...	3
7′ to 7′ 11″	...	...	...	...	...
8′ to 8′ 11″	...	...	...	...	1
					49

The girths of the trees in the above table are at present very uneven and the volume per acre would probably have been much larger if the girths were more even, and the trees had been encouraged to grow up together by judicious early thinnings.

Owing to the present open condition of the crop, between ·8 and ·9, it was impossible to fell trees in this plantation to estimate the volume per acre entirely by means of sample trees, but by means of windfalls, some trees which were felled in a patch of natural teak forest close by, and figures from similar trees in adjacent forest, the volume on the plot was found to be approximately 2,160 cubic feet, including timber and small wood.

In a sample plot in a very similar locality in the Insein Division, the volume standing per acre after thinning was found to be 1,202 cubic feet. This plantation was 20 years old at the date of measurement, and the number of stems per acre after thinning was 262. When the Myodwin plantations were 20 years old they contained, according to the records available, about 300 to 400 trees per acre, so that it appears probable that the small volume of timber per acre now on the area is accounted for by the

lack of proper thinnings when the plantation was young. It is not desired to assert that these figures are accurate or complete but they are quoted in the present article so that later investigation may show whether our present scanty data are of value. On page 4 of the "Memorandum on Teak Plantations in Burma," by F. A. Leete, F.C.H., the author gives as the result of his countings 185 stems per acre at 20 years of age, comparing them with Mr. P. J. Carter's estimate of 250 stems. Mr. Leete's figures are, however, largely from hill *taungya* plantations and the present article deals with plantations made in the plains so that they cannot in all respects be compared. In the plantation of 1864 it is noticeable that there are a comparatively small number of trees irregularly arranged. The canopy is not complete, and the large trees are occupying relatively too much space. This they have been enabled to do by the lack of early thinnings, and they now occupy more room than they should do if the object is to obtain an even growth of well-developed stems on the area.

EXTRACTS.

THE TIMBER OF *CEDRUS DEODARA* GROWN IN ENGLAND.

A member of the R. E. A. S. has inquired whether *Cedrus Deodara* can be grown with advantage as a substitute for larch. He specifically asks (*a*) whether this tree has been grown in England for timber; (*b*) whether it is subject to any special disease; (*c*) whether the timber has a ready market at a remunerative price?

Dealing with these points, I have to say that it is a matter of common observation that the tree grows very fairly in this country and, in fact, in some cases is distinctly vigorous. It is, however, a little sensitive to frost, and this cause is, no doubt, accountable for the fact that many trees show a considerable number of branches killed for a foot or two back from the end. The largest experiment as regards the cultivation of this tree in Britain was, so far as I know, made in the middle of last century or earlier, on Crown lands in the south of England, where, I believe, many thousands of trees were planted out. I saw these trees some ten years ago, and while some in specially favourable situations had grown straight and tall, with a good stem, others were more or less stunted

and clearly going back. I believe that, on the whole, the results are not satisfactory, and I should think that the larch will, in all cases, give a larger and more certain return. It would be useful and interesting if the Office of Woods were to publish the results of the extensive experiments referred to, and perhaps we may be fortunate enough to see this done.

So far as my observations go, the tree is not subject to any special disease, in fact, except for the dying back of the ends of branches, which I attribute to frost, I have not noticed any disease upon the Deodara, although cases are known where, like all other conifers, it has fallen a victim to *Agaricus melleus.*

The quality of the wood is of the highest, but it is doubtful whether English-grown timber of this species put on the market in small quantities would command a better price than larch. In the north of India the timber has a very high reputation, and, according to Dr. Gamble, is moderately hard, strongly scented and oily. There it attains a height of over 200 ft. with a girth of 30 ft. to 40 ft., though it " is probably at its best, in good localities, at about 12 ft. in girth........" Deodara timber is the chief timber of Northern India. Its most important use is for railway sleepers, of which very large numbers are supplied every year to the railway of the north. It is also of value for bridge work, and is employed extensively in building, chiefly for beams and door and window frames, but is rather brittle to work and does not take paint and varnish well. It has also a very strong odour which, pleasant enough in the open air, is rather unpleasant in a room.—[*Quarterly Journal of Forestry.*]

SAVING WOOD WASTE.

A better use of material that is now lost or inefficiently worked up is promoted by the wood-waste exchange of the United States Forest Service, and forest conservation is thus aided. Circulars of information bring to notice the supplies available in the hands of the different producers and the needs of users. The operation of the scheme is shown by the experience of a

Michigan furniture-maker, who had been selling small blocks and sticks of sugar maple for fuel, but who was found a customer at better prices in a maker of scrubbing brushes, who used small maple blocks as backs for brushes.—[*Capital.*]

BIRDS AS MAN'S ALLIES.

That insects, and not man, are the dominant power on earth is the startling assertion of James Buckland in the Smithsonian Annual Report. More than 300,000 species have been described, possibly twice as many are unknown, and these feed on most animals and plants, increasing at such a prodigious rate that one species, developing 13 generations a year, would multiply to ten sextillions of individuals if unchecked to the twelfth generation. Insects, moreover, have astounding appetites. A caterpillar eats twice its weight of leaves in 24 hours, and certain flesh-eating larvæ consume 200 times their weight in the same time, at which rate the infant would devour 1,500 pounds in its first day of life. Against these enemies the birds are our chief protection. A remarkable instance of their service is the elimination of the thistle and the caterpillar from New Zealand by the English sparrow, and another is the saving of Australian agriculture from grasshoppers by the straw-necked ibis, individuals of which crammed themselves with 2,400 grasshoppers at a time. Paying $ 90,000 in bounties for exterminating hawks and owls, Pennsylvania lost $ 3,850,000 from the resulting increase in rodents.—[*Capital.*]

OBLITERATING FORESTS.

It is not only with iron, steel, and copper that the battles of France are being fought, but with wood as well. And, while the outlays for arms and ammunition are enormous, they do not represent a more oppressive tax upon the French people than will be the net cost to that country of the present reckless destruction of her forests. That at least is the view of one Frenchman of

note, M. Jean Paul Alaux, an eminent architect of Paris, who is now at the front, and has had many opportunities to view the devastation that war works in the wooded countries along the battle-front. In "American Forestry" for March he declares the havoc of the European war in this respect to be "without precedent in history," and names the following causes contributing to it :--

"1. Cuttings by the military authorities for strategic reasons and for permitting the more effective use of artillery.

"2. Cuttings for the purpose of building trenches, shelters, and roads.

"3. Cutting for firewood for the military kitchens and for fuel with which to warm the shelters.

"4. Cutting by the enemy and the taking away of timber as valuable booty.

"5. Damages by projectiles and by fires, whether due to accident or design."

Even as far south as Paris the forests have already been damaged by the war, for in the threatened attack on Paris in the first weeks of the German invasion it was deemed necessary to cut paths in some places for the artillery fire, and to destroy possible ambushes available to the enemy. Montmorency suffered severely ; the Vincennes and Boulogne have so far escaped serious cuttings. In the North, we learn :

"The winter rains have rendered most of the roads impassable, especially in the wooded regions. In the forest of Bouvigny, near Arras, and in the forest of Berthonval, the artillerymen were unable to move their guns over the muddy and entrenched roads, and it was impossible even to transport ammunition. In order to keep the guns supplied it was necessary to cut new roads in all directions through the forests, using the felled trees for the purpose. The trunks, in sections of about twelve feet, are laid side by side and bound together with ropes and with galvanised iron wire. They are further securely fastened to stakes driven deep in the ground. The first layer of trees having proved insufficient, a second was added. This again failing to suffice, a third became necessary, until in many cases three layers of trees are superposed in order to

permit the passage of convoy waggons. To avoid the too rapid wear of the wood through the grinding of the heavy wheels and the tearing of the horses' shoes, earth mixed with straw, bark and the twigs and small branches of the fallen trees is strewn plentifully over these improvised roadways.

" Other cuttings have been made in these forests, both for shelters and for firewood. Concealment of the heavy guns on the edge of the forest has necessitated the use of large quantities of the bigger branches, so that the sum total of what has been already cut represents a very considerable damage. A wood merchant in my regiment tells me that it will require at least thirty years to renew the growth of that which has already perished, so that the forests shall return a revenue."

The forest of Vitrimont has been completely razed, as has the beautiful wood near Neufchateau, before the fort of Bourlemont. In the forest of Champenoux every tree was cut down to a height of three feet. The forest of Meaux, the plateau of Amance before Nancy, the wood of Crevie, near Arancourt, and many others, have been either destroyed or terribly gashed. Of his own experiences M. Alaux writes:

" For serveral weeks I have been quartered in the vicinity of Arras. In the wood of La Haye all of the trees and undergrowth have been cut practically throughout the whole area of the forest. It was done for the purpose of providing firewood for the kitchen and shelters. Daily I have seen the men file away, axe and bill-hook in hand, to return later laden down with great bundles of wood, which they threw down beside their shelters, and which they would afterward split with wooden wedges.

" To construct our subterranean shelters, which are practically shell-proof, we use roof-supports consisting of small trunks of trees from four to six inches in diameter. Resting on these are the split slabs, in two courses, separated by small branches or straw. Over the whole is strewn earth to the depth of about eighteen inches. In order to keep the rain and melting snow from finding its way through this roof, a shelter-roof is built overhead. This is composed of bundles of small branches and straw, which are

laid at a proper angle, and which rest upon a small sapling stretched across the roof area. They serve as an umbrella to protect the roof beneath.

"While it is true that much of the wood employed in constructing these shelters and in building trenches and roads will not be wholly lost, it will, of course, serve no other purpose than that of firewood. But even this service is problematical, and will, of course, depend largely upon the duration of the campaign. We also cut off large branches with which to mask the heavy guns and the caissons of ammunition, which are generally stationed near the edge of the wood. This practice is everywhere in vogue as a means of preventing the discovery of their location from the prying eyes of the aeroplanists."

What the hand of man has not done for the express purpose of offence or defence, the hail of shells from the Austrian 42 cm. and French "75" has accomplished. Few bits of woodland have escaped along the front, but among the few, happily, are the beautiful forests of Chantilly and Compiègne, which mark the southernmost advance of the Germans, and were not held long enough to permit much damage.

The French Department of Forestry has already restricted. to a large extent the uses that may be made of the larger forests by the military. But it is difficult to enforce these regulations, and, also, we are told:

"The indiscriminate 'gashing,' which is generally the custom in such work, will render the damage much greater than one thought would be the case, even though the regulations were properly observed. . . .

"I am told that the enemy have cut down huge quantities of trees in the Argonne, transporting the timber to their own country, as booty of quickly realisable value. This represents a real disaster—one which it will require long, long years to repair."—[*The Timber Trades Journal.*]

TIMBER FIREPROOFING.

According to the "Surveyor" the directors of the London and North-Western Railways have decided after full investigation and exhaustive trial, to instal a plant at their Wolverton works for the purpose of rendering wood fireproof by the "Oxylene" process. The wood so fireproofed is to be used in the construction of their railway carriages, waggons, etc., and the plant to be installed will be capable of dealing with 150,000 cubic feet of wood per annum.—[*Indian Engineering.*]

FIFTY YEARS OF FOREST ADMINISTRATION IN BASHAHR.

PART I

FROM 1864 TO 1892.

BY. H. M. GLOVER, I.F.S.

In the present article I shall endeavour to consider the general effects of regular management during the last fifty years on the forests of the Bashahr State and the way in which the development of the forests has reacted on the prosperity of the State. Details sufficient only for understanding the local conditions will be given; while further information can, if desired, be obtained from the Simla Hill States *Gazetteer* published in 1910, Messrs. Hart and Gibson's Sutlej Valley Working-Plan published in 1906, and Mr. Lace's Working-Plan published in 1892. I have borrowed largely from all these sources in the following paragraphs.

The Bashahr Forest Division comprises the leased forests in the Native State of Bashahr, and the two small reserved forests

Fig. 1.

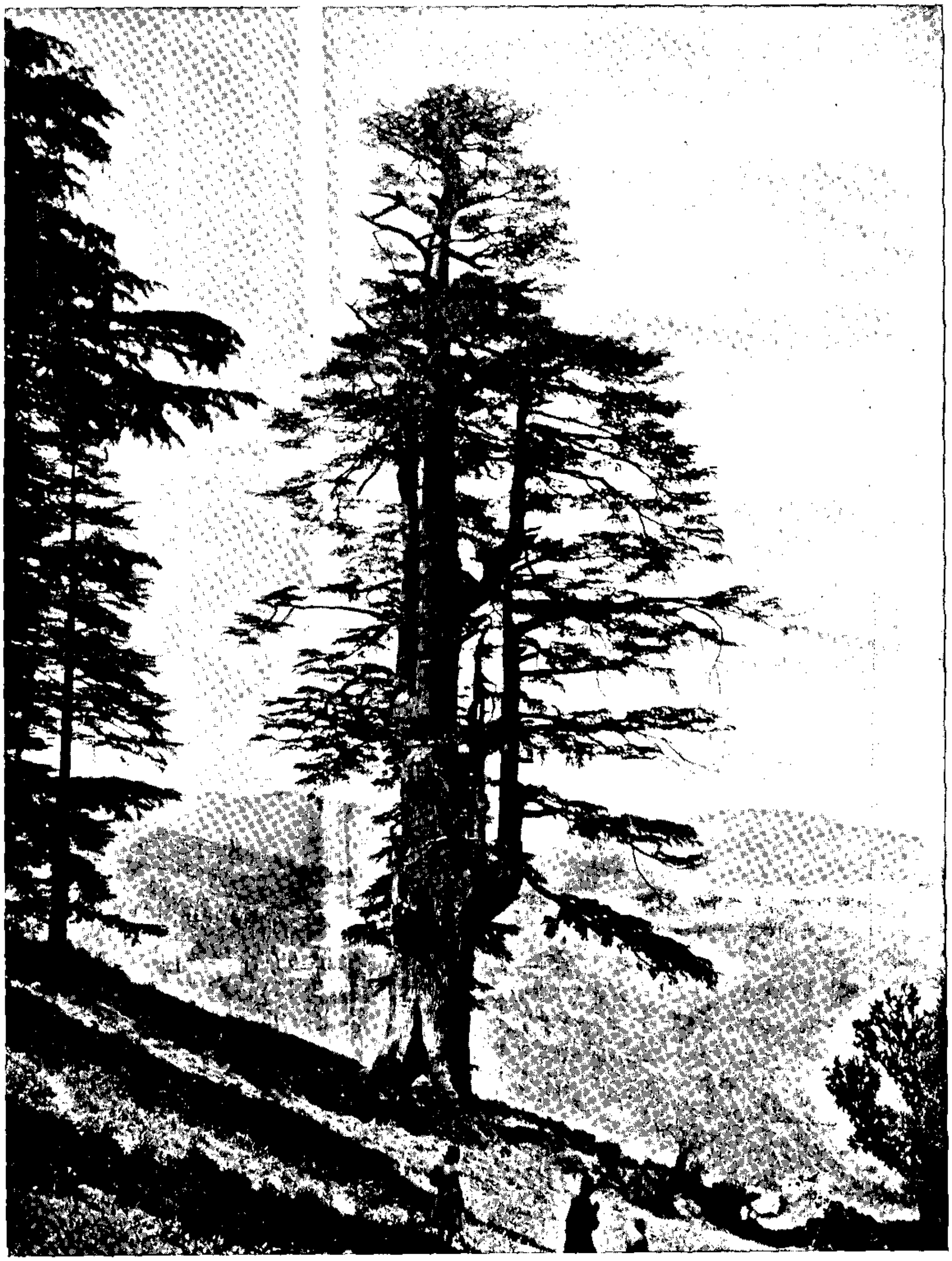


Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

LARGE DEODAR.

(Girth 35 feet 9 inches).

of Phillaur and Ludhiana. The Divisional Forest Officer also controls the timber traffic of the Sutlej river from the borders of Tibet to the boundary of the Montgomery district. He is also Political Assistant to the Superintendent of Hill States, Simla, and possesses magisterial powers.

Bashahr, the largest of the Simla Hill States, is situated in the north-east corner of the Punjab and is bounded on the north by Spiti, on the east by Chinese Tibet, on the south by Garhwal, and on the west by Kulu, Kotgarh and the Native States of Kumharsain and Kaneti. The State is about 3,820 square miles in area and for the greater part lies within the drainage area of the Sutlej river, which runs in a general direction from north-east to south-west, and has a total length within the State of about 98 miles. Two immense mountain chains bound the Sutlej drainage area on the north and south, both rising to snow-clad peaks from 16,000 to 21,000 feet in elevation. The chain on the south is the most western portion of the great central chain of the Eastern Himalayas, which sends an offshoot to the south-east and forms the watershed between the Pabar and the Sutlej rivers and, incidentally, between the Indian and the Arabian oceans. *Simla lies on an offshoot of this ridge. Another more important* branch is that to the north-west of the Baspa valley, which has many peaks with an elevation of from 18,000 to 21,000 feet.

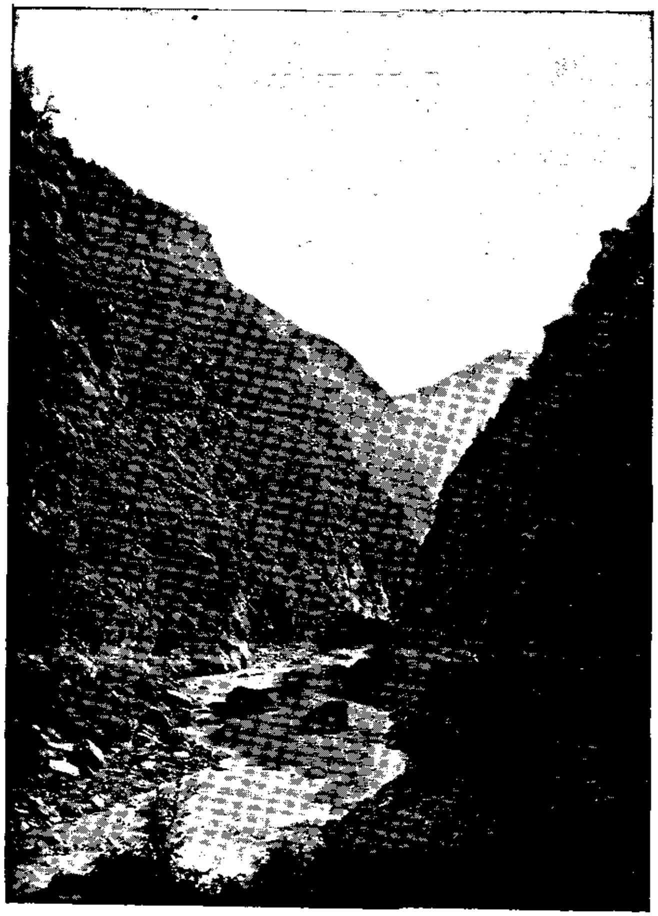
The country is formed of a great mass of mountain spurs with very precipitous sides jutting out in every direction from the main ranges, between which there are narrow ravines or small rivers with sheer banks. The Sutlej descends from about 7,600 feet near the Thibetan border to 2,800 feet a little below Rampur, flowing almost the whole way between narrow cliffs, or steep mountain slopes so that there is no open ground to speak of along its banks. The only level ground of any extent in Bashahr is in the Baspa valley at an elevation of from 8,000 to 8,500 feet, caused by the action of ancient glaciers and moraines. Throughout the greater part of the valley the rocks are formed of granite gneiss, and quartzite, while in the Pabar and lower Sutlej valley metamorphosed schists occur.

Along the valley of the Sutlej as far east as Wangtu and on the Pabar side of the watershed the rainfall does not vary greatly from that of Simla, being possibly somewhat greater; but beyond Wangtu the difference is considerable, the rainfall becoming less and less as Tibet is approached, so that the climate of Upper Kanawar is semi-arid. At Kilba, the former head-quarters of the division, the rainfall is only 25 inches, while at Poo some 12 miles from the Tibetan border and beyond the limit of exploitable tree growth this drops to 12 inches. Practically speaking, the monsoon rains are spent before they reach Chini, and most of the precipitation is in the winter in the form of snow. Throughout the valley except at the lowest levels snow lies deep all the winter and most of the forests are then inaccessible. Avalanches are frequent at high elevations and at times have ploughed long lines through the forests, at least one instance being known of a village having been swept away. Generally speaking, the climate is moderate in summer except in secluded valleys at low elevations where the heat is intense, while in winter the more accessible portions are not exceptionally cold.

In the upper parts of the valley the country is thinly populated and cultivation is not extensive owing to the precipitous nature of the ground and its altitude. The villages are generally small and are usually situated below the forest areas, though during the summer months many of the people live in hamlets in their Alpine fields, which for the most part are found near the upper limit of deodar and frequently within the forest boundaries. Some two or three hundred years ago cultivation was more extensive, many of the best deodar forests being found on abandoned fields. Indeed throughout Bashahr the zones of deodar and cultivation coincide so that often the deodar forests are relegated to steep or unculturable slopes bordering on cultivation.

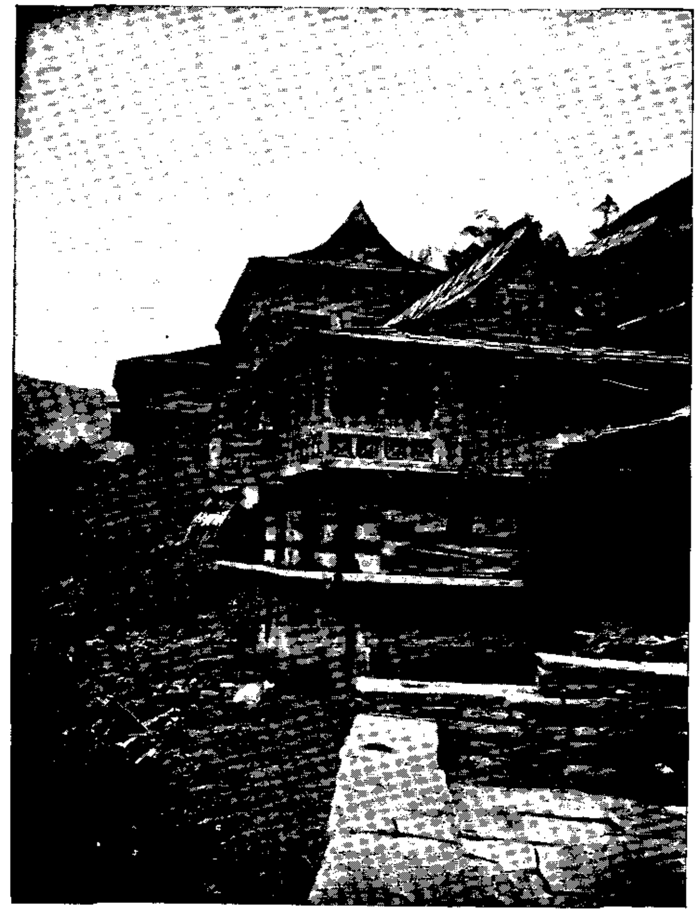
In Kanawar the grain grown locally is not sufficient for the wants of the population and much maize and corn is imported, a large portion of the community being engaged in trade with Tibet and the plains.

Fig. 2.



The Karcham Gorge, Sutlej Valley.

Fig. 3.



Village houses.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

The predominant caste is Kanet with Dagis as menials, the people becoming more Mongolian in characteristics as the Tibetan border is approached. Here too Hinduism merges into Buddhism and the people are universally polyandrous, owing to the shortage of land which makes it impossible to support a large population. The life of the people is intimately connected with the forests from which they obtain all their requirements of grazing, fodder, timber, firewood, etc., and over which they have extensive rights. The regulation of grazing is not difficult owing to the large grazing grounds both above and below the demarcated forests. The lower grazing grounds are burnt in the winter months and fires now rarely spread to the demarcated forests, whereas before the lease every forest was burnt at frequent intervals. Houses are substantially built and a large quantity of wood is used in their construction as will be seen from the accompanying photograph (Plate No. 7B, fig. 3).

The forests in the Sutlej and Pabar valleys differ in character, deodar being more prevalent in the former, and blue pine in the latter. The Pabar forests are under a separate Working-plan and will be described later. The forests vary in composition in different parts of the Sutlej valley, the determining factor being the amount of the rainfall. In the lower Sutlej valley where the rainfall is considerable they consist of blue pine (*Pinus excelsa*), silver fir (*Abies Webbiana*), spruce (*Picea Morinda*), oaks in three zones and of three species (*Quercus incana*, *dilatata* and *semecarpifolia*), deodar (*Cedrus Deodara*), birch and broad-leaved trees closely allied to European species. They form a continuous belt of dense forest interspersed with patches of cultivation which increase as the lower levels are approached. At elevations below 5,000 to 6,000 feet they give place to cultivation, thinly stocked chir (*Pinus longifolia*) forests and extensive bare grassy slopes. Deodar very occasionally forms pure woods but is generally found scattered through the blue pine forests where it is frequently of great size. As the upper valley is approached the proportion of deodar increases and in the semi-arid zone it forms pure woods ; blue pine, firs, and broad-leaved trees cease

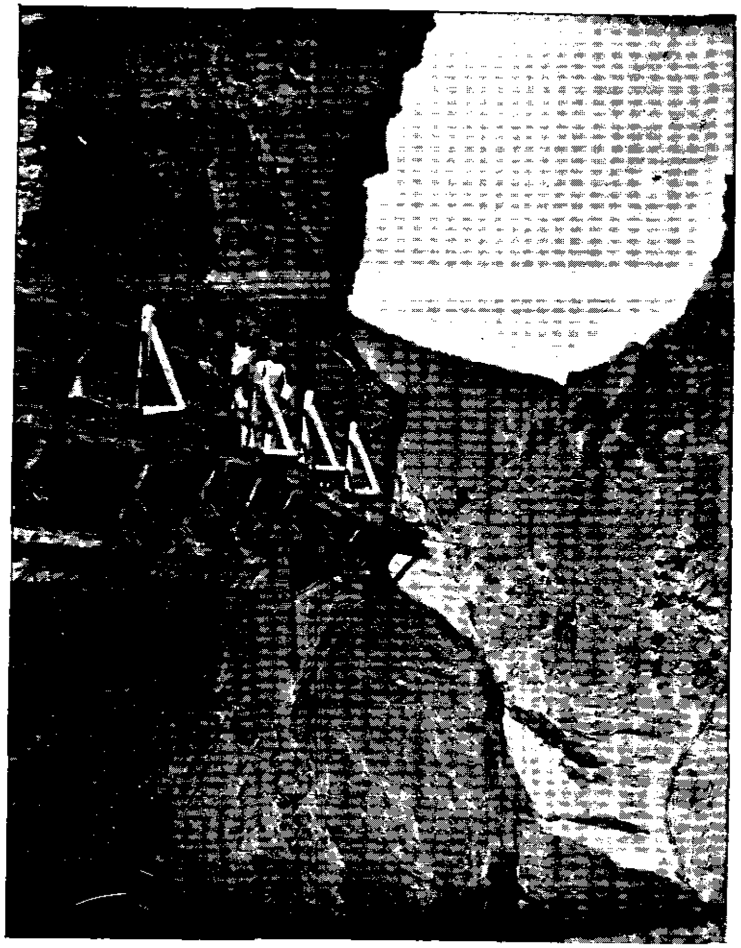
to form large woods and deodar is found in workable quantity and size up to 10,500 feet, attaining its best development between 8,500 and 9,500 feet. The edible pine (*Pinus Gerardiana*) is met with in considerable quantities and occupies the lower slopes above the Sutlej, which are however very thinly stocked with trees, while grass gives place to *Artemisia*. Above the forests Alpine meadows merge into bare wastes of snow and rock, glaciers and inaccessible mountain peaks. Most of the forests are exceedingly precipitous and workable patches of deodar are generally confined to the comparatively level ground above and below precipices. In the side valleys the rainfall is heavier and forests are more numerous, the appearance of the country bearing a marked contrast to the barren lower slopes of the main valley. The streams are often a succession of cataracts rendering the floating of timber and the construction of timber slides matters of great difficulty. Towards the Tibetan border the deodar becomes very stunted, repeated snowbreaks resulting in the formation of bushes a few feet high. Vegetation becomes very scarce and the country presents a bleak and dreary aspect.

HISTORY.

But little is known of the Bashahr forests before 1850. At that time large mature trees were plentiful and out of all proportion to the lower girth classes, which, together with young regeneration, had been destroyed by frequent fires, which appear to have repeatedly passed through all forests, and to the present day have left the marks of their ravages on the old overmature trees still standing. Shifting cultivation was common and resulted in the destruction of large areas of forest. Deodar (literally "abode of the god") forests in the neighbourhood of temples were regarded as sacred and trees were only felled for temple repairs or after sacrifice to the local god.

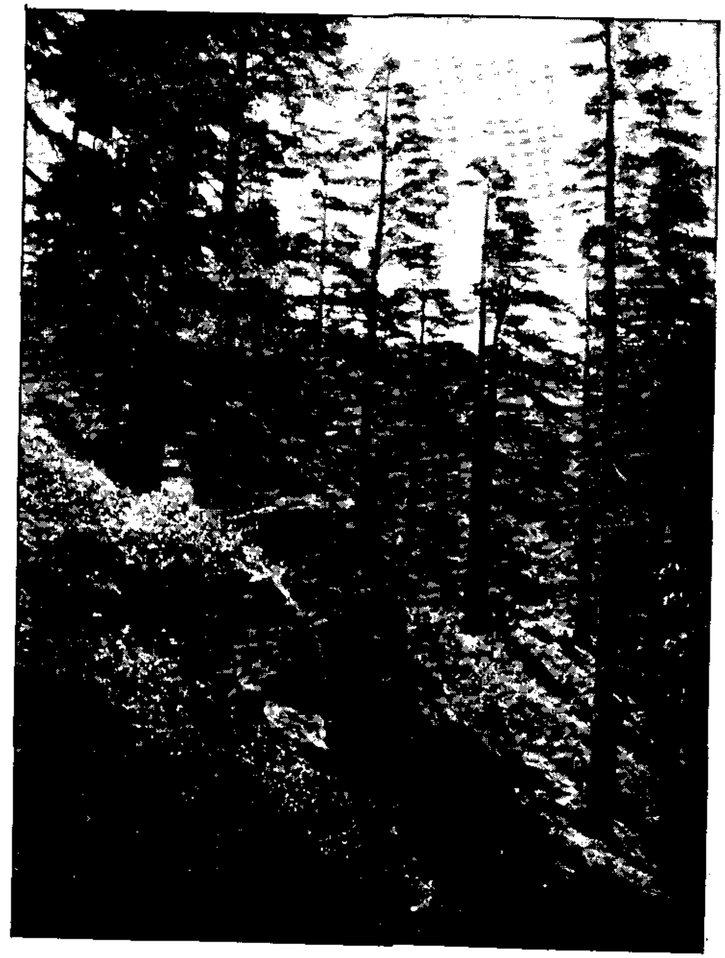
In 1850, however, a native trader purchased deodar trees from the Raja at two annas each. He was followed a few years afterwards by European traders who commenced to fell all the accessible deodar forests. The Raja granted 'parwanas' to

Fig. 4.



Galleries on Karcham—Shongtong road.

Fig. 5.



A Deodar Forest under regeneration.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

these traders, a bag of rupees being sufficient to fell an indefinite number of trees, and even this payment was often avoided. All timber was extracted in logs generally of 10 to 12 feet in length for sawing into railway sleepers in the plains; waste was excessive and little care was taken to avoid logs being smashed, the operation being profitable if one log in ten reached the river. Generally one log in three was lost before reaching the river and Dr. Cleghorn in 1862 estimated that of the logs felled in the forest from one-quarter to one-third only reached the sale depôts.

The reports about this time (1862) form very interesting reading, and although every writer comments on the rapid rate at which the forests were being destroyed the following description gives one some idea of the stand of virgin timber:—" In Nichar forest I measured a tree after felling 122 feet long, the butt end girth 14 feet 6 inches and top 12 feet 4 inches, another standing about 150 feet high, girth at bottom 18 feet 4 inches; these are not exceptions, some I measured 26 feet in girth. The average, taking the whole forest, is not less than 15 feet in girth at bottom." Again of another forest " I measured five trees and found them the following girths at bottom, 26 feet 9 inches, 21 feet 6 inches, 22 feet, 18 feet, and 26 feet 4 inches. These are exceptions to the general forest but the trees are of good girth and height, and the average height of the trees is not less than 150 feet." The Raja found the greatest difficulty in dealing with traders who constantly avoided their obligations and was anxious for the forests to be leased by Government and an European officer to be placed in charge.

A lease was eventually concluded by Government in 1864, a fixed royalty being paid for each tree felled. A large profit was not anticipated, but the necessity for preserving these forests in the drainage area of the Sutlej was realised.

Dr. (afterwards Sir Dietrich) Brandis, in company with various other Forest Officers, made a rough survey of the Bashahr forests in 1864 and has left on record some very interesting remarks as to their condition. He calculated that between 1859 and 1863 30,000 deodar trees had been felled from the more accessible

forests, and notes that a large proportion of the forests on the lower slopes of the hills had been completely cleared; while the following remarks are significant and would appear to be typical :—

"A few years ago the greater part of the large sized trees was felled but not removed. Fire entered in the dry season, and what was formerly a rich forest with 33 first class trees on the acre, is now a barren slope covered with charred stumps and trees killed by the fire." He comments on the very large amount of timber left behind in the forests and on the great destruction to timber caused by the rough methods of extraction. At the foot of one slide he counted upwards of one thousand logs and splintered pieces of logs and notes that he observed many similar instances of the destruction of timber. After a few general remarks on the necessity of forest conservancy he says :—"In the deodar forests of Bashahr the expediency of conservancy is palpable. Since 1859, 30,000 trees have been felled and a large proportion of the more accessible forests ruined beyond the hope of restoration. This has been accomplished in five years, and if the felling is continued at the same rate ten years more will suffice to clear out and ruin the whole of the forests available under the present system of working. We should then in 1874 be reduced to those forests which require the sawing up of timber, artificial slides and roads for land transport. Under a similar system these may last ten years more but after 1884 the resources of the forests would be completely exhausted. The tracts where young deodar is springing up form a very small proportion of the original forests." A rough scheme for felling the more accessible forests was drawn up, prescribing regular regeneration fellings combined with sowing and planting, and allowing for the removal on all first class deodar trees from accessible forests during the succeeding sixteen years. Artificial regeneration was, however, to be subsidiary to endeavours to obtain natural regeneration.

In accordance with Brandis' proposals departmental exploitation was started while some traders were allowed to finish off the balances of their contracts. More detailed proposals were drawn

up in 1874 which provided for an expenditure of Rs. 3,000 a year on works of improvement.

The lease was revised in 1877, Government agreeing to pay a fixed annual sum of ten thousand rupees to the Raja on a fifty years' lease renewable in perpetuity at the will of Government. Rules were introduced and the next few years were occupied in the departmental extraction of timber, in inducing the villagers to conform to the rules, in supplementing natural regeneration in the areas worked departmentally, and in only partially successful attempts to restock artificially the areas devastated by traders' fellings and subsequent fires. One of the most essential acts was to stop piracy by Native States lower down the Sutlej, who stole hundreds of Government logs on the pretence that they had an immemorial right to all timber passing their shores.

In 1881 Dr. Brandis and Dr. (afterwards Sir William) Schlich visited Bashahr. The proposed fellings had not nearly been carried out, and for some years after the forests were leased, departmental timber operations were confined to the extraction of logs left in the streams and forests by traders and to the cutting up of wind-fallen trees, 1,970 green deodar only being felled by the Forest Department between 1864 and 1874. Other fellings were made on behalf of Messrs. Brassey and Co., the Raja, and villagers, bringing up the total number of green and wind-fallen deodar cut between 1864 and 1875 to 16,000. It was now proposed to fell 2,000 trees annually, and inclusive of much timber which had been left over from previous operations it was expected that 200,000 cubic feet of timber would be delivered yearly at the sale depôts. The intensity of the fellings appeared too small for the proper establishment of natural regeneration, although it was noted that the results since 1864 had been exceedingly satisfactory. Messrs. Brandis and Schlich accordingly suggested that mature trees should be clear felled in groups separated from one another by intervening belts of mature trees, and that mature trees standing above regeneration should be removed. They comment, however, on the bare slopes on which valuable forests had been destroyed by traders previous to the lease, and it may be

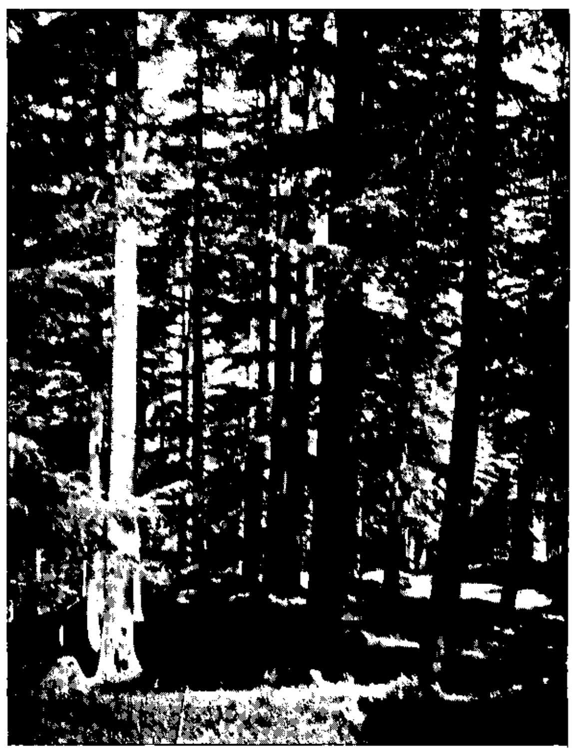
noted that even now many of these areas are easily identified by the large numbers of old stumps persisting on otherwise barren hillsides despite the numerous attempts to reafforest them. The necessity of adequate protection against fire and excessive grazing in regeneration areas was insisted on, and the diversity of local conditions in Kanawar and in Lower Bashahr was taken into consideration. Girdling of trees of species other than deodar was suggested in order to free young deodar advance growth, and burning of felling debris and brushwood and subsequent sowings in patches were recommended. Communications, which were almost entirely lacking except for the main Hindustan-Tibet road, which generally lies below the forest zone, received attention, but the standard of work suggested was not high. The working of the rules seems to have been satisfactory, forest fires having almost entirely ceased, and shifting cultivation and illicit fellings having been restricted.

Between 1882 and 1892 the average yield prescribed in 1881 was somewhat exceeded. Regeneration fellings were carried out according to the "Regular method," felling operations lasting for several years in the same forest. Wear and tear were considerable but the operations usually resulted in sufficient natural regeneration. Cultural operations consisted partly of supplementary and usually successful sowing and planting in areas where natural regeneration had partially failed and partly of more or less unsuccessful attempts to restock forests destroyed by traders. An average annual amount of Rs. 1,173 was spent on new roads and Rs. 1,003 on repairs, new bridle-paths costing from Rs. 56 to Rs. 380 per mile. When precipices were met with, which was often, the road ascended or descended steeply, and in some places where precipices ran sheer down into the Sutlej wooden galleries were constructed jutting out from the face of the rock. The funds available did not allow of good roads being built, and most of the bridle-paths have since been re-constructed. Inspection paths cost about Rs. 30 per mile and were even steeper in gradient. The Sutlej was bridged in several places by wooden cantilever bridges costing about Rs. 2,000 each. In other places rope or

Fig. 6.

Crossing the Buran Pass (about 15,500 ft) in June 1915.

Fig. 7.



A Deodar Forest.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College Roorkee

wire Jhulás were used. A forest settlement report was submitted and about 1889 some 106,000 acres of forest were demarcated by Mr. G. E. Minniken, Deputy Conservator of Forests. Grants of building timber to right-holders were still very heavy owing to no fees being levied for trees according to the terms of the lease, and much timber was wasted as all trees were converted without using the saw.

The average yearly surplus had risen from Rs. 4,500 between 1864-65 and 1879-80 to Rs. 16,800 from 1882-83 to 1891-92.

In 1892 a regular Working-plan was drawn up by Mr. J. H. Lace, Deputy Conservator of Forests, and what may be called the "pioneering period" of forestry in Bashahr came to an end.

The general results had been satisfactory; forest fires which had been very frequent before the lease, had been almost entirely stopped; excessive waste in exploitation had been put an end to; the more valuable forests had been demarcated; rules for the regulation of rights of user had been introduced and the villagers had become accustomed to them; departmental operations had proved financially successful; exploited areas had to a considerable extent been regenerated; some attempt at developing communications had been made; and, generally speaking, the way had been prepared for more intensive and scientific management.

In Part II the further development of the resources of the forests and the progress of a more advanced forest administration will be described.

(*To be continued.*)

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THE OLIVE (*OLEA CUSPIDATA*) FORESTS OF THE PUNJAB.

BY B. O. COVENTRY, I.F.S.

DISTRIBUTION AND AREA.

The **olive** is occasionally met with in the Himalayas up to elevations of about 6,000 feet and more frequently in the arid zone of the Himalayas beyond the reach of the monsoon rains, such as in the Sutlej Valley above Wangtu. It is however on the low arid hills of the Salt Range region, which is the northern portion of the Punjab to the west of the Himalayas, that the **olive** is met with abundantly, and in this region fairly extensive mixed and gregarious forests of **olive** are found. The forests are confined to the cool northern slopes, and plateaux of these low hills, which comprise the Salt Range in the Jhelum Division and the Kalachitta and Khairimurat Ranges in the Rawalpindi Division, the elevation of the hills extending to about 3,500 feet. Except in a few places at the foot of the Kalachitta Range where it has extended from the steeper slopes, the **olive** does not occur naturally in the plains. It is frequently met with planted in gardens in the plains, and a few fairly good specimens are to be seen in the Lawrence Gardens, Lahore, which were planted about 30 years ago.

The area of the **olive** forests is estimated to be approximately about 100 square miles.

ENVIRONMENT.

The climate of the Salt Range region is characterised by great heat with long periods of drought in the hot weather months and by considerable cold with moderate frosts at night in the winter months. Owing to closer proximity to the Himalayas, more northern latitude, and greater elevation, the climate of this region is one of rather higher rainfall, less intense heat in the summer months and greater cold in the winter months, as compared with that of the plains region to the south where the Jand forests occur. The mean annual rainfall varies from about 30 inches in the north-east to about 15 inches at the south-west near the Indus river, thus gradually decreasing with distance from the Himalayas as the following figures will show :—

	W					E	
N	Attock 19″	...	Fattehjang	25″	...	Rawalpindi	32″
			Pindigheb Chakwal Talagang	18″	...	Gujar Khan	30″
S	Sakesar 17″	...	Pind Dadan Khan.	17″	...	Jhelum	26″

TOPOGRAPHY.

The Salt Range region consists partly of high alluvial plains and partly of low outlying ranges of hills. The alluvial plains are at an elevation of about 1,000 feet to 1,700 feet, the ground gradually sloping away from the Himalayas in a south-west direction to the river Indus. Owing to the high level of the alluvial plains there is a great tendency for the rivers to cut down vertically lowering their beds much below the surface of the surrounding country. This has resulted in the plains being much cut up with ravines with deep vertical sides, which is very noticeable in the tract of country passed through by the North-Western Railway between Jhelum and

Gujar Khan, giving it the appearance of a miniature Colorado, and is also very marked in the Pindigheb district. The hill ranges are low outlying ranges of hills rising abruptly from the surrounding plains to elevations of about 3,500 feet and running more or less parallel to each other with their main axes extending from east to west. Of these hill ranges the most extensive one is the Salt Range, which extends across the Jhelum and Shahpur districts from the Jhelum river to the Indus river over a distance of about 100 miles. The Salt Range reaches an elevation of 3,200 feet at Mount Tilla which is about 10 miles from Jhelum, the top of Mount Tilla being a small plateau of about 20 acres in extent, and at Sakesar on the western extremity it reaches its maximum elevation of 5,000 feet. Its strata consist of limestone, sandstone, shales and marls, below which there is a very extensive deposit of rock salt from which the range derives its name, and which forms one of the chief sources of supply of salt in India. Seams of coal also occur in the Salt Range and the principal mine is at Dandot. The Kalachitta Range extends across the Attock district from the Indus river eastwards to a distance of about 50 miles. The strata consist of a hard nummulitic limestone and a soft friable sandstone, and are inclined at a steep angle in such a way that the limestone is on the northern side and the sandstone on the south. The contrast between the dark colour of the sandstone and the light colour of the limestone gives the range a black and white appearance from which the name Kalachitta (meaning black and white) is derived. The Khairimurat Range is a much smaller range being about 15 miles in length, and situated 15 miles from Rawalpindi, from which it can be seen standing out from the plains like a huge rock, and is locally known as the "Gibraltar Rock." Its strata are similar to those of the Kalachitta Range, being limestone on the north and sandstone on the south side. These hill ranges are all much cut up by ravines, but in the Kalachitta and Khairimurat Ranges this is much more marked on their southern slopes which consist of soft sandstone, than on their northern slopes of hard limestone. In the Kalachitta and Khairimurat Ranges there is very little soil

on the northern slopes, the solid limestone subsoil being much exposed. On their southern slopes a shallow soil from the disintegration of the sandstone occurs, but it is constantly undergoing denudation, so that no great depth of soil accumulates. There is practically an entire absence of humus soil on both slopes. On the Salt Range there is a good depth of loamy soil with humus in some localities, although elsewhere the subsoil rock is much exposed. The drainage from the Salt Range runs partly into the Indus river and partly into the Jhelum river, and that from the Kalachitta and Khairimurat Ranges into the Indus river.

Description of the Forests.

The best **olive** forests are found in the Salt Range in localities where there is a good depth of soil. In such localities the **olive** forms fairly extensive and well-stocked gregarious forests. In localities where the subsoil rock is exposed the forests are of a more open nature and the **olive** is found associated with other species especially the Phulai (*Acacia modesta*), and shrubs such as Sanatta (*Dodonæa viscosa*), Garunda (*Carissa spinarum*), Ganger (*Sageretia Brandrethiana*), Bahekar (*Adhatoda Vasica*), etc. In the better parts of the Kalachitta the **olive** is much associated with Gurgura (*Reptonia buxifolia*), a species peculiar to this part of the Punjab. Generally speaking, the more the subsoil rock is exposed the less the proportion of **olive** in the forests and the greater the preponderance of Phulai so that all degrees of mixture of these two species are met with. In the Kalachitta and Khairimurat ranges the **olive** forests are entirely on a limestone subsoil, which gives the impression that the **olive** shows a preference for a limestone subsoil, but in the Salt Range it is found growing equally well on sandstone, shale and other subsoils. The prevalence of the **olive** on limestone in the former ranges is thus only a coincidence, due to the fact that the cool northern slopes of these ranges are of limestone only. Where the limestone subsoil is exposed the **olive** trees are found growing directly out of the limestone with their roots penetrating into deep fissures in the rock. In the better type of forests in the Salt Range and in

parts of the Kalachitta Range well-grown trees with girths up to four or five feet may be met with, but over the greater part of the forests the trees are more of the nature of clumps of coppice shoots or root-suckers and show evidence of maltreatment in the past by reckless cuttings and browsing of goats. Occasionally fine trees of very large girth are met with in the neighbourhood of shrines, where they have been regarded as sacred and thereby escaped molestation.

LIFE-HISTORY.

Although abundant crops of seed are produced, there is an entire absence of natural regeneration from seed in the Kalachitta and Khairimurat forests. During the time that the writer was in charge of the Rawalpindi Division the usual explanations put forward to account for this were that it was due to infertility of the seed or to goat-browsing which destroyed the seedlings as soon as they appeared, and it was not until February 1911 when the writer had an opportunity of touring in the Salt Range forests of the Jhelum Division that the explanation of the failure of natural regeneration in the Kalachitta and Khairimurat forests became clear to him. In the Salt Range forests numerous seedlings of **olive** were found on Mount Tilla and in the Drengan and Phadial forests, but the best regeneration was found in the Gandala forest alongside the Gandala stream just below the Choha Saidan Shah Range quarters. *The seedlings were invariably found in shade under the protection* of some tree or shrub, and never in the open where the soil was exposed to the sun, and they were always found on good humus soil. Many of the seedlings found on Mount Tilla had only recently germinated and had the cotyledonary leaves still attached, showing that germination takes place in February. A seedling of 9 inches height was found to be three years old, the growth of the first year being 2 inches, of the second year 2½ inches and of the third year 4½ inches which shows that the **olive** is very slow growing from seed. A comparison of the conditions in the Salt Range with those in the Kalachitta and Khairimurat Ranges leaves little doubt that the failure of natural regeneration in the latter forests is due to the absence of humus soil

as the result of the denudation of the surface soil. It is also evident that the **olive** forests in the Kalachitta and Khairimurat Ranges originated at a time when there was a good covering of humus soil above the limestone rock, but which has since been denuded leaving the limestone rock exposed. This is the only way in which the presence of the **olive** trees growing out of the solid limestone subsoil can be accounted for. It is probable that these hills have been in a denuded condition for a considerable period, and that in the absence of natural regeneration from seed, propagation has taken place by means of root-suckers. The denudation of the humus soil and the reversion of the soil to its original non-humus condition has resulted in the failure of natural regeneration of **olive** from seed, the trees gradually dying off, and becoming replaced by Phulai, a species which regenerates on poor non-humus soil, thus illustrating a rotation of crops and explaining the occurrence together of these two species to form mixed forests, although each species requires entirely different conditions of soil for its natural regeneration. It may also be assumed that prior to the appearance of **olive** on the ground, the forests consisted of Phulai and other species which regenerate on a non-humus soil, and that as the soil improved and became enriched with humus, the Phulai was gradually replaced by **olive**.

The denudation of the surface soil in the Kalachitta and Khairimurat forests is probably due to reckless cutting of the forests in the past and the overrunning of the forests by numberless goats of which extensive flocks are still kept in the neighbouring villages.

It is quite clear from the above that if natural regeneration of **olive** from seed is to be obtained in these forests measures must be directed towards stopping further denudation and encouraging the accumulation of soil and humus, such as the restriction of grazing and browsing and the terracing of slopes and nalas. It would probably take many years for the soil to improve sufficiently for natural regeneration to take place, but until humus soil collects above the limestone subsoil natural regeneration from seed cannot be expected.

UTILITY OF THE FORESTS.

The forests in the Kalachitta Range are worked under the coppice-with-standards system, with a rotation of 30 years for the coppice. The Working-plan was introduced about 20 years ago, and it was considered at that time that the best method for improving the poor condition of the crop was to apply the coppice-with-standards system with the object of replacing the clumps of malformed stems by good clean coppice shoots. The outturn from the forests is chiefly utilised as firewood, but a certain number of poles are extracted for the use of the local villagers who use them for rafters for their houses. The foliage of the **olive** is a valuable fodder for camels, and being evergreen is especially valuable for this purpose in the winter months when the Phulai is leafless. Most of the **olive** forests have recently been included in schemes for providing permanent browsing grounds for the camels of the Military Camel Corps. It is probable that if there were a good permanent supply of large **olive** timber available, it would be of considerable value for export, as it resembles boxwood in some respects and is often beautifully mottled with a dark brown colour. The outturn in firewood from these forests varies considerably owing to the great variations in the density of the crop, but may be estimated to average about 300 c. ft. stacked per acre.

Experiments have been in progress during the last three or four years to endeavour to introduce the European cultivated variety of the **olive** tree, which yields the "Olives" of commerce, by grafting on to the indigenous trees.

SYLVICULTURAL NOTES ON THE OLIVE.

The **olive** is a middle-sized evergreen tree, and a shade-bearer. It produces a dense crop of foliage of small dark green leaves with a brownish under-surface. It attains a height of 30 feet to 40 feet and a girth of 6 feet or more, and lives to a considerable age. It is slow growing from seed, natural seedlings attaining a height of 9 inches in three years, but developing a long tap-root.

It flowers about April to May and produces an abundant crop of fruit which ripens in October. The fruit when ripe is a small

black ovoid drupe about one-third of an inch long, the seed after removal of the outer fleshy covering being enclosed in a thick hard woody shell. It coppices vigorously producing a great number of shoots from the stool, of which the stronger ones attain a height of about 10 feet in five years.

The wood is hard, heavy and close-grained and is often mottled with dark brown markings giving it a beautiful appearance when polished. It is much used for making combs, walking-sticks and other fancy articles.

The wood makes good firewood, and charcoal, and the foliage is an excellent fodder for camels and goats. The weight of the wood is 70 lbs. per c. ft.

For natural regeneration from seed to take place the surface soil should be a moist well-drained humus soil, with protection from the sun.

For sowings the seed may be sown in any good humus soil, but the soil should be kept moist and the seedlings shaded until they are well established.

FIFTY YEARS OF FOREST ADMINISTRATION IN BASHAHR.

PART I

FROM 1864 TO 1892.

BY, H. M. GLOVER, I.F.S.

In the present article I shall endeavour to consider the general effects of regular management during the last fifty years on the forests of the Bashahr State and the way in which the development of the forests has reacted on the prosperity of the State. Details sufficient only for understanding the local conditions will be given; while further information can, if desired, be obtained from the Simla Hill States *Gazetteer* published in 1910, Messrs. Hart and Gibson's Sutlej Valley Working-Plan published in 1906, and Mr. Lace's Working-Plan published in 1892. I have borrowed largely from all these sources in the following paragraphs.

The Bashahr Forest Division comprises the leased forests in the Native State of Bashahr, and the two small reserved forests

Fig. 1.

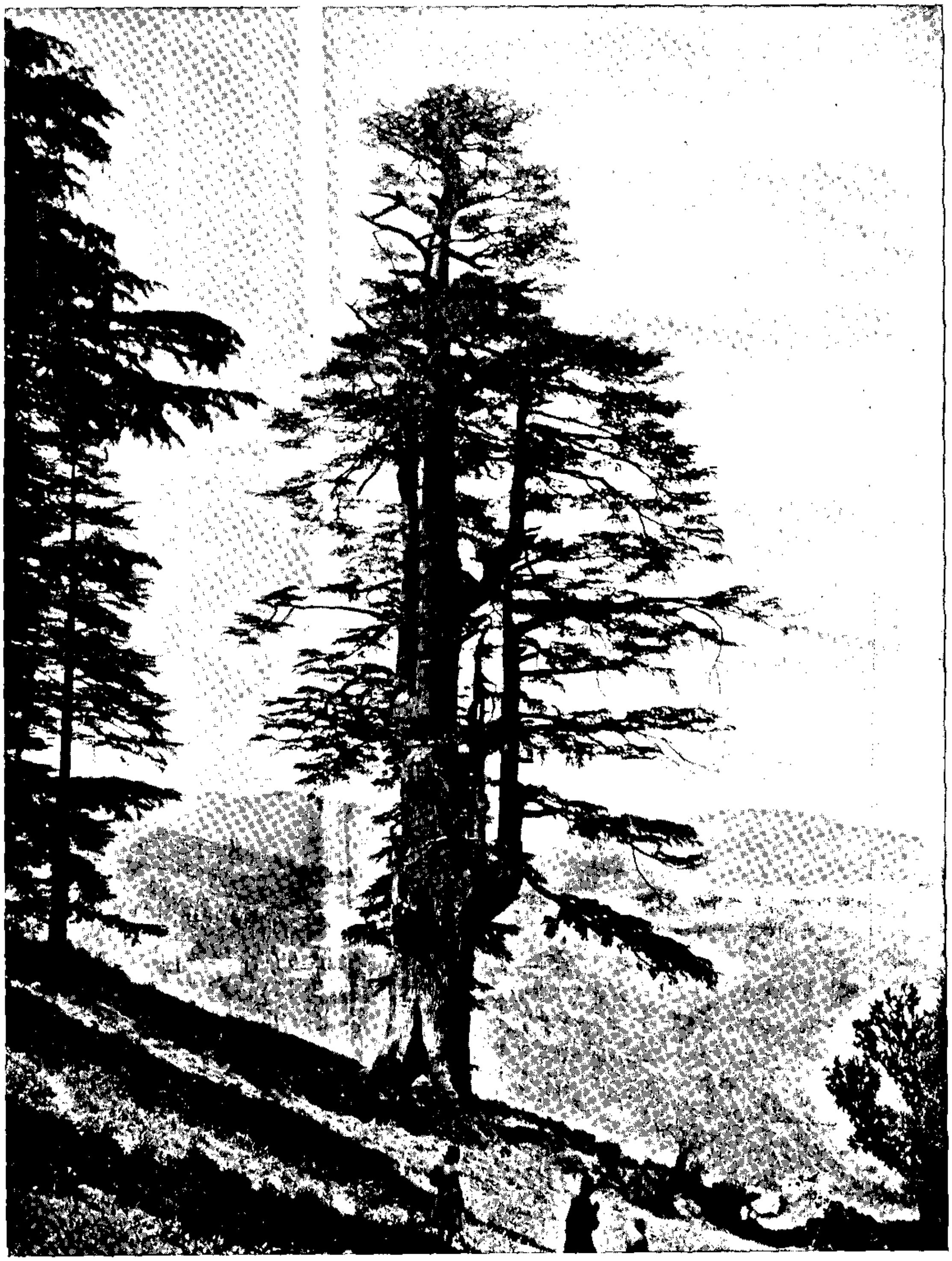


Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

LARGE DEODAR.
(Girth 35 feet 9 inches).

of Phillaur and Ludhiana. The Divisional Forest Officer also controls the timber traffic of the Sutlej river from the borders of Tibet to the boundary of the Montgomery district. He is also Political Assistant to the Superintendent of Hill States, Simla, and possesses magisterial powers.

Bashahr, the largest of the Simla Hill States, is situated in the north-east corner of the Punjab and is bounded on the north by Spiti, on the east by Chinese Tibet, on the south by Garhwal, and on the west by Kulu, Kotgarh and the Native States of Kumharsain and Kaneti. The State is about 3,820 square miles in area and for the greater part lies within the drainage area of the Sutlej river, which runs in a general direction from north-east to south-west, and has a total length within the State of about 98 miles. Two immense mountain chains bound the Sutlej drainage area on the north and south, both rising to snow-clad peaks from 16,000 to 21,000 feet in elevation. The chain on the south is the most western portion of the great central chain of the Eastern Himalayas, which sends an offshoot to the south-east and forms the watershed between the Pabar and the Sutlej rivers and, incidentally, between the Indian and the Arabian oceans. *Simla lies on an offshoot of this ridge. Another more important* branch is that to the north-west of the Baspa valley, which has many peaks with an elevation of from 18,000 to 21,000 feet.

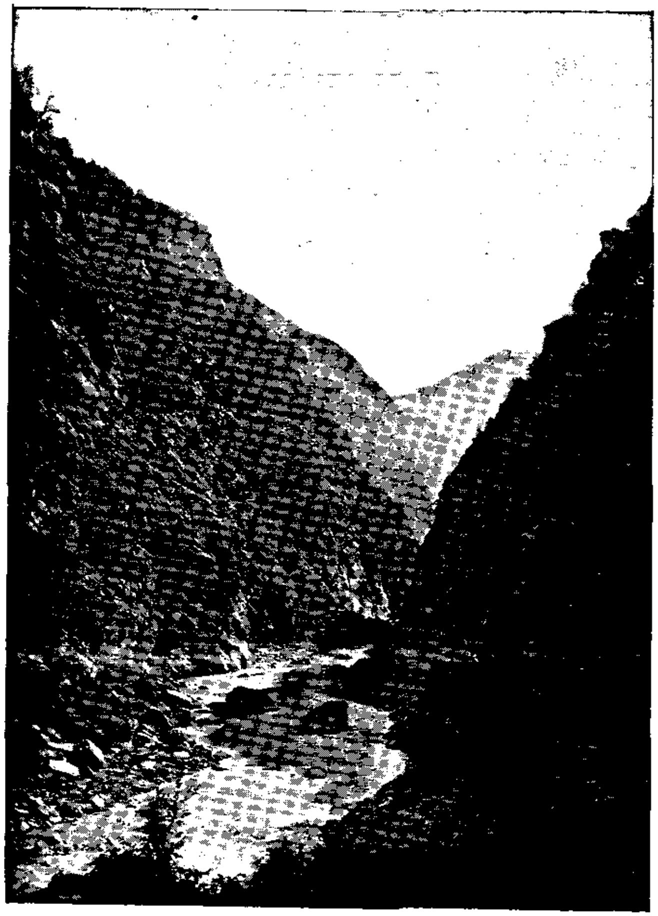
The country is formed of a great mass of mountain spurs with very precipitous sides jutting out in every direction from the main ranges, between which there are narrow ravines or small rivers with sheer banks. The Sutlej descends from about 7,600 feet near the Thibetan border to 2,800 feet a little below Rampur, flowing almost the whole way between narrow cliffs, or steep mountain slopes so that there is no open ground to speak of along its banks. The only level ground of any extent in Bashahr is in the Baspa valley at an elevation of from 8,000 to 8,500 feet, caused by the action of ancient glaciers and moraines. Throughout the greater part of the valley the rocks are formed of granite gneiss, and quartzite, while in the Pabar and lower Sutlej valley metamorphosed schists occur.

Along the valley of the Sutlej as far east as Wangtu and on the Pabar side of the watershed the rainfall does not vary greatly from that of Simla, being possibly somewhat greater; but beyond Wangtu the difference is considerable, the rainfall becoming less and less as Tibet is approached, so that the climate of Upper Kanawar is semi-arid. At Kilba, the former head-quarters of the division, the rainfall is only 25 inches, while at Poo some 12 miles from the Tibetan border and beyond the limit of exploitable tree growth this drops to 12 inches. Practically speaking, the monsoon rains are spent before they reach Chini, and most of the precipitation is in the winter in the form of snow. Throughout the valley except at the lowest levels snow lies deep all the winter and most of the forests are then inaccessible. Avalanches are frequent at high elevations and at times have ploughed long lines through the forests, at least one instance being known of a village having been swept away. Generally speaking, the climate is moderate in summer except in secluded valleys at low elevations where the heat is intense, while in winter the more accessible portions are not exceptionally cold.

In the upper parts of the valley the country is thinly populated and cultivation is not extensive owing to the precipitous nature of the ground and its altitude. The villages are generally small and are usually situated below the forest areas, though during the summer months many of the people live in hamlets in their Alpine fields, which for the most part are found near the upper limit of deodar and frequently within the forest boundaries. Some two or three hundred years ago cultivation was more extensive, many of the best deodar forests being found on abandoned fields. Indeed throughout Bashahr the zones of deodar and cultivation coincide so that often the deodar forests are relegated to steep or unculturable slopes bordering on cultivation.

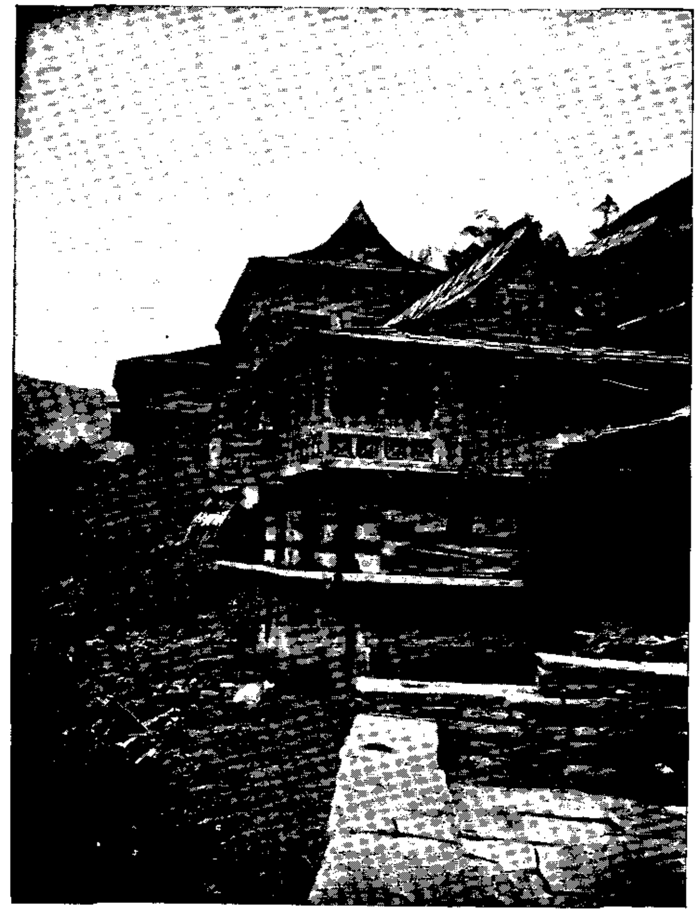
In Kanawar the grain grown locally is not sufficient for the wants of the population and much maize and corn is imported, a large portion of the community being engaged in trade with Tibet and the plains.

Fig. 2.



The Karcham Gorge, Sutlej Valley.

Fig. 3.



Village houses.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomasson College, Roorkee.

The predominant caste is Kanet with Dagis as menials, the people becoming more Mongolian in characteristics as the Tibetan border is approached. Here too Hinduism merges into Buddhism and the people are universally polyandrous, owing to the shortage of land which makes it impossible to support a large population. The life of the people is intimately connected with the forests from which they obtain all their requirements of grazing, fodder, timber, firewood, etc., and over which they have extensive rights. The regulation of grazing is not difficult owing to the large grazing grounds both above and below the demarcated forests. The lower grazing grounds are burnt in the winter months and fires now rarely spread to the demarcated forests, whereas before the lease every forest was burnt at frequent intervals. Houses are substantially built and a large quantity of wood is used in their construction as will be seen from the accompanying photograph (Plate No. 7B, fig. 3).

The forests in the Sutlej and Pabar valleys differ in character, deodar being more prevalent in the former, and blue pine in the latter. The Pabar forests are under a separate Working-plan and will be described later. The forests vary in composition in different parts of the Sutlej valley, the determining factor being the amount of the rainfall. In the lower Sutlej valley where the rainfall is considerable they consist of blue pine (*Pinus excelsa*), silver fir (*Abies Webbiana*), spruce (*Picea Morinda*), oaks in three zones and of three species (*Quercus incana*, *dilatata* and *semecarpifolia*), deodar (*Cedrus Deodara*), birch and broad-leaved trees closely allied to European species. They form a continuous belt of dense forest interspersed with patches of cultivation which increase as the lower levels are approached. At elevations below 5,000 to 6,000 feet they give place to cultivation, thinly stocked chir (*Pinus longifolia*) forests and extensive bare grassy slopes. Deodar very occasionally forms pure woods but is generally found scattered through the blue pine forests where it is frequently of great size. As the upper valley is approached the proportion of deodar increases and in the semi-arid zone it forms pure woods; blue pine, firs, and broad-leaved trees cease

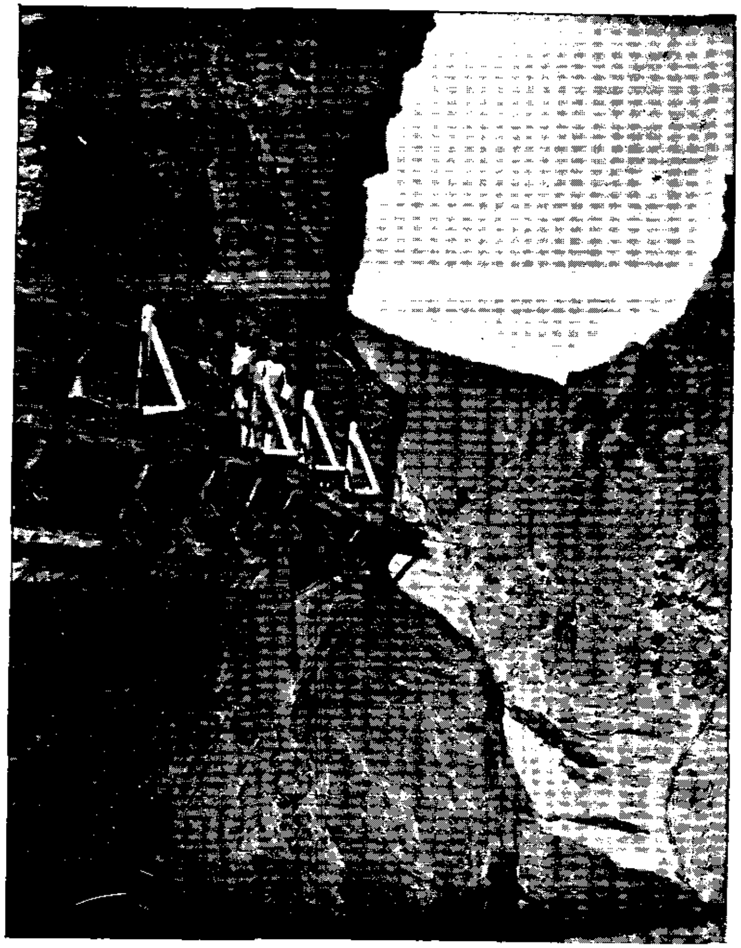
to form large woods and deodar is found in workable quantity and size up to 10,500 feet, attaining its best development between 8,500 and 9,500 feet. The edible pine (*Pinus Gerardiana*) is met with in considerable quantities and occupies the lower slopes above the Sutlej, which are however very thinly stocked with trees, while grass gives place to *Artemisia.* Above the forests Alpine meadows merge into bare wastes of snow and rock, glaciers and inaccessible mountain peaks. Most of the forests are exceedingly precipitous and workable patches of deodar are generally confined to the comparatively level ground above and below precipices. In the side valleys the rainfall is heavier and forests are more numerous, the appearance of the country bearing a marked contrast to the barren lower slopes of the main valley. The streams are often a succession of cataracts rendering the floating of timber and the construction of timber slides matters of great difficulty. Towards the Tibetan border the deodar becomes very stunted, repeated snowbreaks resulting in the formation of bushes a few feet high. Vegetation becomes very scarce and the country presents a bleak and dreary aspect.

HISTORY.

But little is known of the Bashahr forests before 1850. At that time large mature trees were plentiful and out of all proportion to the lower girth classes, which, together with young regeneration, had been destroyed by frequent fires, which appear to have repeatedly passed through all forests, and to the present day have left the marks of their ravages on the old overmature trees still standing. Shifting cultivation was common and resulted in the destruction of large areas of forest. Deodar (literally "abode of the god") forests in the neighbourhood of temples were regarded as sacred and trees were only felled for temple repairs or after sacrifice to the local god.

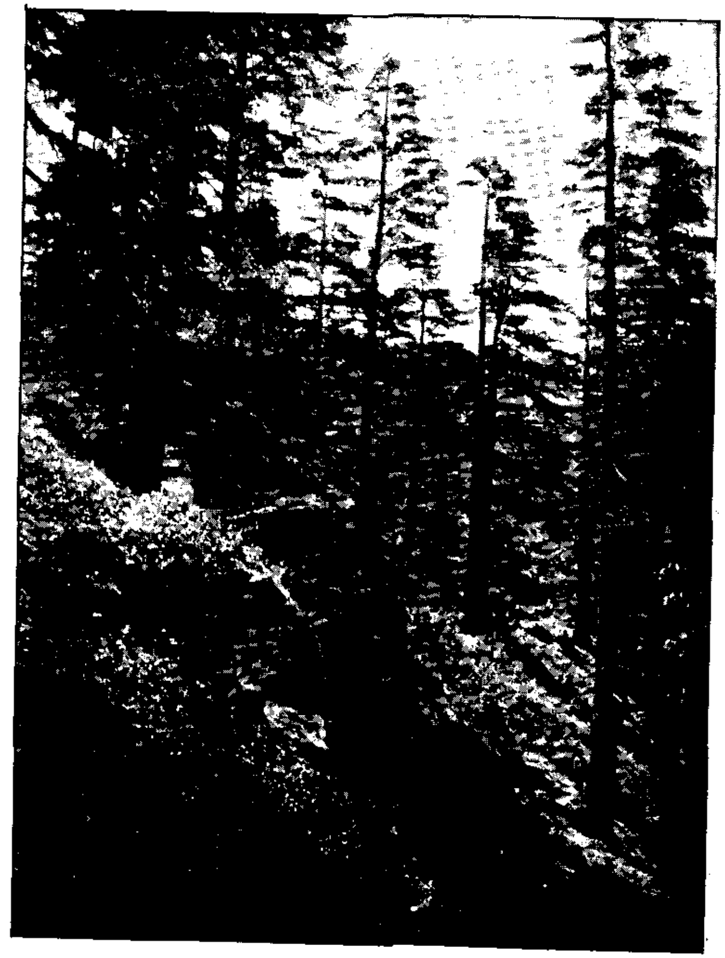
In 1850, however, a native trader purchased deodar trees from the Raja at two annas each. He was followed a few years afterwards by European traders who commenced to fell all the accessible deodar forests. The Raja granted 'parwanas' to

Fig. 4.



Galleries on Karcham—Shongtong road.

Fig. 5.



A Deodar Forest under regeneration.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

these traders, a bag of rupees being sufficient to fell an indefinite number of trees, and even this payment was often avoided. All timber was extracted in logs generally of 10 to 12 feet in length for sawing into railway sleepers in the plains; waste was excessive and little care was taken to avoid logs being smashed, the operation being profitable if one log in ten reached the river. Generally one log in three was lost before reaching the river and Dr. Cleghorn in 1862 estimated that of the logs felled in the forest from one-quarter to one-third only reached the sale depôts.

The reports about this time (1862) form very interesting reading, and although every writer comments on the rapid rate at which the forests were being destroyed the following description gives one some idea of the stand of virgin timber:—" In Nichar forest I measured a tree after felling 122 feet long, the butt end girth 14 feet 6 inches and top 12 feet 4 inches, another standing about 150 feet high, girth at bottom 18 feet 4 inches; these are not exceptions, some I measured 26 feet in girth. The average, taking the whole forest, is not less than 15 feet in girth at bottom." Again of another forest " I measured five trees and found them the following girths at bottom, 26 feet 9 inches, 21 feet 6 inches, 22 feet, 18 feet, and 26 feet 4 inches. These are exceptions to the general forest but the trees are of good girth and height, and the average height of the trees is not less than 150 feet." The Raja found the greatest difficulty in dealing with traders who constantly avoided their obligations and was anxious for the forests to be leased by Government and an European officer to be placed in charge.

A lease was eventually concluded by Government in 1864, a fixed royalty being paid for each tree felled. A large profit was not anticipated, but the necessity for preserving these forests in the drainage area of the Sutlej was realised.

Dr. (afterwards Sir Dietrich) Brandis, in company with various other Forest Officers, made a rough survey of the Bashahr forests in 1864 and has left on record some very interesting remarks as to their condition. He calculated that between 1859 and 1863 30,000 deodar trees had been felled from the more accessible

forests, and notes that a large proportion of the forests on the lower slopes of the hills had been completely cleared; while the following remarks are significant and would appear to be typical :—

"A few years ago the greater part of the large sized trees was felled but not removed. Fire entered in the dry season, and what was formerly a rich forest with 33 first class trees on the acre, is now a barren slope covered with charred stumps and trees killed by the fire." He comments on the very large amount of timber left behind in the forests and on the great destruction to timber caused by the rough methods of extraction. At the foot of one slide he counted upwards of one thousand logs and splintered pieces of logs and notes that he observed many similar instances of the destruction of timber. After a few general remarks on the necessity of forest conservancy he says :—" In the deodar forests of Bashahr the expediency of conservancy is palpable. Since 1859, 30,000 trees have been felled and a large proportion of the more accessible forests ruined beyond the hope of restoration. This has been accomplished in five years, and if the felling is continued at the same rate ten years more will suffice to clear out and ruin the whole of the forests available under the present system of working. We should then in 1874 be reduced to those forests which require the sawing up of timber, artificial slides and roads for land transport. Under a similar system these may last ten years more but after 1884 the resources of the forests would be completely exhausted. The tracts where young deodar is springing up form a very small proportion of the original forests." A rough scheme for felling the more accessible forests was drawn up, prescribing regular regeneration fellings combined with sowing and planting, and allowing for the removal on all first class deodar trees from accessible forests during the succeeding sixteen years. Artificial regeneration was, however, to be subsidiary to endeavours to obtain natural regeneration.

In accordance with Brandis' proposals departmental exploitation was started while some traders were allowed to finish off the balances of their contracts. More detailed proposals were drawn

up in 1874 which provided for an expenditure of Rs. 3,000 a year on works of improvement.

The lease was revised in 1877, Government agreeing to pay a fixed annual sum of ten thousand rupees to the Raja on a fifty years' lease renewable in perpetuity at the will of Government. Rules were introduced and the next few years were occupied in the departmental extraction of timber, in inducing the villagers to conform to the rules, in supplementing natural regeneration in the areas worked departmentally, and in only partially successful attempts to restock artificially the areas devastated by traders' fellings and subsequent fires. One of the most essential acts was to stop piracy by Native States lower down the Sutlej, who stole hundreds of Government logs on the pretence that they had an immemorial right to all timber passing their shores.

In 1881 Dr. Brandis and Dr. (afterwards Sir William) Schlich visited Bashahr. The proposed fellings had not nearly been carried out, and for some years after the forests were leased, departmental timber operations were confined to the extraction of logs left in the streams and forests by traders and to the cutting up of wind-fallen trees, 1,970 green deodar only being felled by the Forest Department between 1864 and 1874. Other fellings were made on behalf of Messrs. Brassey and Co., the Raja, and villagers, bringing up the total number of green and wind-fallen deodar cut between 1864 and 1875 to 16,000. It was now proposed to fell 2,000 trees annually, and inclusive of much timber which had been left over from previous operations it was expected that 200,000 cubic feet of timber would be delivered yearly at the sale depôts. The intensity of the fellings appeared too small for the proper establishment of natural regeneration, although it was noted that the results since 1864 had been exceedingly satisfactory. Messrs. Brandis and Schlich accordingly suggested that mature trees should be clear felled in groups separated from one another by intervening belts of mature trees, and that mature trees standing above regeneration should be removed. They comment, however, on the bare slopes on which valuable forests had been destroyed by traders previous to the lease, and it may be

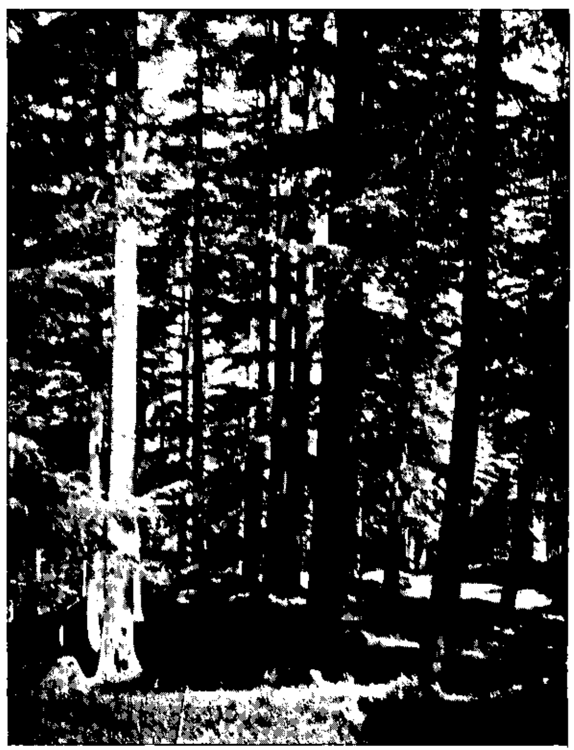
noted that even now many of these areas are easily identified by the large numbers of old stumps persisting on otherwise barren hillsides despite the numerous attempts to reafforest them. The necessity of adequate protection against fire and excessive grazing in regeneration areas was insisted on, and the diversity of local conditions in Kanawar and in Lower Bashahr was taken into consideration. Girdling of trees of species other than deodar was suggested in order to free young deodar advance growth, and burning of felling debris and brushwood and subsequent sowings in patches were recommended. Communications, which were almost entirely lacking except for the main Hindustan-Tibet road, which generally lies below the forest zone, received attention, but the standard of work suggested was not high. The working of the rules seems to have been satisfactory, forest fires having almost entirely ceased, and shifting cultivation and illicit fellings having been restricted.

Between 1882 and 1892 the average yield prescribed in 1881 was somewhat exceeded. Regeneration fellings were carried out according to the "Regular method," felling operations lasting for several years in the same forest. Wear and tear were considerable but the operations usually resulted in sufficient natural regeneration. Cultural operations consisted partly of supplementary and usually successful sowing and planting in areas where natural regeneration had partially failed and partly of more or less unsuccessful attempts to restock forests destroyed by traders. An average annual amount of Rs. 1,173 was spent on new roads and Rs. 1,003 on repairs, new bridle-paths costing from Rs. 56 to Rs. 380 per mile. When precipices were met with, which was often, the road ascended or descended steeply, and in some places where precipices ran sheer down into the Sutlej wooden galleries were constructed jutting out from the face of the rock. The funds available did not allow of good roads being built, and most of the bridle-paths have since been re-constructed. Inspection paths cost about Rs. 30 per mile and were even steeper in gradient. The Sutlej was bridged in several places by wooden cantilever bridges costing about Rs. 2,000 each. In other places rope or

Fig. 6.

Crossing the Buran Pass (about 15,500 ft) in June 1915.

Fig. 7.



A Deodar Forest.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College Roorkee

wire Jhulás were used. A forest settlement report was submitted and about 1889 some 106,000 acres of forest were demarcated by Mr. G. E. Minniken, Deputy Conservator of Forests. Grants of building timber to right-holders were still very heavy owing to no fees being levied for trees according to the terms of the lease, and much timber was wasted as all trees were converted without using the saw.

The average yearly surplus had risen from Rs. 4,500 between 1864-65 and 1879-80 to Rs. 16,800 from 1882-83 to 1891-92.

In 1892 a regular Working-plan was drawn up by Mr. J. H. Lace, Deputy Conservator of Forests, and what may be called the "pioneering period" of forestry in Bashahr came to an end.

The general results had been satisfactory; forest fires which had been very frequent before the lease, had been almost entirely stopped; excessive waste in exploitation had been put an end to; the more valuable forests had been demarcated; rules for the regulation of rights of user had been introduced and the villagers had become accustomed to them; departmental operations had proved financially successful; exploited areas had to a considerable extent been regenerated; some attempt at developing communications had been made; and, generally speaking, the way had been prepared for more intensive and scientific management.

In Part II the further development of the resources of the forests and the progress of a more advanced forest administration will be described.

(*To be continued.*)

KEY TO FOREST FLORA OF THE SOUTHERN CIRCLE, CENTRAL PROVINCES.

BY H. H. HAINES, I.F.S.

Artificial Key to the Trees, Shrubs, Climbers and Undershrubs.

PART II.—SHRUBS.

Plants with distinctly woody stems and main branches, not usually exceeding 15 ft., often with several stems or large branches from near the root, or branched low down, excluding Palms (q. v.).

a. Not parasitic on the branches of other trees or shrubs.

I. Leaves simple.

A. Leaves opposite or whorled (often fascicled in 275—278).

§ Margins of leaves quite entire (see also 314).

* Leaves penni-nerved.

† Juice milky.

(1) Armed with simple or 3-fid. spines.

Erect L. ·5—1·5 mostly acute and apiculate. Fls. small white star-shaped.	267	327	Carissa spinarum.
Erect or straggling, cultivated. L. 1·5—3″ shining, tip rounded or obtuse.	268	328	Carissa Carandas.

(2) Unarmed.

Large shrub or small tree. L. 4—12″. Peti. 0—·25″ (No. 4).	269	332	Holarrhena.
Large garden shrub. L. 2—6″ glossy, sec. n. 6—8. Peti. ·25—·5″. Fls. white.	270	335	Tabernæ montana.
Large L. 3—6 in a whorl, 4—8″ lanceolate acuminate. Sec. n. over 30.	271	330	Alstonia venenata.
Large garden shrub. L. 2—3 in a whorl, 4—8″ linear lanceolate. Sec. n. over 30.	272	337	Nerium.

Shrub 5—12 ft. with large whitish leaves woolly beneath. Fls. with spreading corolla.	273	342	Calotropis gigantea.
Shrub 3—6 ft. L. similar to 273 but less woolly. Fls. with erect corolla lobes.	274	343	Calotropis procera.

†† Juice not milky.

(1) Armed with thorns or prickles. L. often in fascicles.

Bark black. L. obovate to oblong obtuse 2—8″. Fls. large white 1·5—2″ (14).	275	301	Randia uliginosa.
Bark brown. L. obovate obtuse or acute 1—4″. Fls. m. s. white (13).	276	302	Randia dumetorum.
L. glabrous or pubescent ovate or oblong acute or acuminate 3—4″. Fls. very small greenish 5-merous. Fr. large 1—1·5″ diam. globose (12).	277	305	Vangueria.
Spines close and decussate often exceeding the ·5—2·5″ long glabrous obtuse leaves. Fls. very small 4-merous (11).	278	303	Canthium parviflorum.
Cult. or semi-wild. L. lanceolate or narrow rhomboid ·7—1·5. Fls. small cream.	279	279	Lawsonia.
Cult. (Pomegranate) L. about 2″ obtuse. Fls. m. s. scarlet.	280	280	Punica.

(2) Unarmed (see also 275, 279 and 280 above which are sometimes nearly thornless).

(*a*) L. pellucid dotted with interior oil glands.	281	271	Eugenia Heyneana.
(*b*) L. with minute black dots on lower surface.	282	276	Memecylon.

(*c*) L. with minute glistening yellow glands on lower surface.

Tall shrub with bark peeling off in vertical strips. Fls. blue. L. ell. acuminate.	283	413	Caryopteris.
Large sarmentose shrub. Fls. white. L. deltoid or ovate, often glabrous.	284	410	Clerodendron phlomoides.

(*d*) L. with small peltate scales on lower surface.

Sarmentose shrub with rusty shoots, ovate or ell. acuminate leaves 2·5—5″.	285	269	Calycopteris.
Erect bushy shrub with sub-sessile lanceolate leaves 2·5—4″ and scarlet fls.	286	281	Woodfordia.

(*e*) Leaves without glands or scales (exc. sometimes in the nerve axils).

x Leaves with interpetiolar stipules.

Bushy, with gummy buds, ell. oblong leaves 4—8″ acute both ends. Sec. n. 20—25.	287	297	Gardenia lucida.
Stem usually single, white. Buds gummy. L. oblong to obovate 1·5—3″ with usually sub-cordate sub-sessile base. Sec. n. 12—16.	288	298	Gardenia gummifera.
Usually a small tree with pale bark. Buds gummy. L. broadly ell. to orbicular sub-sessile 5—10″. Sec. n. 12 (19).	289	299	Gardenia latifolia.
Shrub 4—6 ft. L. glossy oblanceolate-oblong 3—7″. Petiole ·3—·5″. Fls. ·4—·6″ white in terminal corymbs.	290	296	Webera.

Shrub or small tree with compressed twigs, 2-ranked ovate or lanc.-ovate acuminate leaves 3·5—6″. Sec. n. 4—6 usually with gland pits in their axils. Fls. axillary.	291	304	Canthium didymum.
L. coriaceous glabrous 3—6″ with rounded or cordate base and obtuse tip. Fls. panicled.	292	307	Ixora.
L. ell. or obovate pubescent 3—8″. Sec. n. 11—15. Peti. ·5—1″. Fls. panicled, white.	293	306	Pavetta.
Fœtid when bruised. L. stiff 4—9″. Sec. n. 15—20 strong. Peti. ·25—·75″. Fls. lilac.	294	309	Hamiltonia.

x Leaves without stipules.

o Indigenous jungle shrubs.

Large, sarmentose. L. ell. to oblong shining coriaceous 4—7″. Fls. irregular.	295	79	Hiptage.
Large, sarmentose. L. ovate to ovate-lanceolate, pubescent till old, 2—5″. Fls. reg.	296	321	Jasminum arborescens.

oo Hedge and garden shrubs.

Large, sarmentose. L. broadly ovate pubescent beneath (see also 284). Peti. ·5—1″. Fls. white, 2-lipped (305).	297	410	Clerodendron phlomoides.
Large, erect. L. ell. or oblong, sessile, glabrous, 2″. Fls. showy, regular.	298	278	Lagerstrœmia indica.
Erect with fœtid odour. L. ell. 6—10″ acute. Fls. 2-lipped white, spicate.	299	394	Adhatoda.

Erect. L. 1·5—2′ glaucous beneath. Peti. ·3—·5. Fls. small deep red (Sandal). 300 431 **Santalum.**

** Leaves palmi-nerved.

Handsome shrub covered with strigose hairs. L. broad lanceolate 3—4″. Fls. mauve. 301 275 **Melastoma.**

§§ Margins of leaves not entire.

* Leaves penni-nerved.

† Branches armed with thorns or prickles. Semi-wild or garden shrubs.

Aromatic. Branches with short prickles. L. rugose serrate. Fls. capitate. 302 396 **Lantana.**

Usually thorny. L. ·5—1·5″ (see also 304) 303 405 **Gmelina asiatica.**

†† Unarmed.

(1) Leaves with minute peltate or glistening glands on under surface.

Bark brown. L. ovate to obovate ·3—1·5″ lobed. 304 405 **Gmelina asiatica.**

Sarmentose. L. broadly ovate 1·5—3·5″, crentate or crenate-serrate (284, 297). 305 410 **Clerodendron phlomoides.**

Branches erect. L. often ternate, sub-sessile, oblong or ell. 3—6″. Fls. blue lipped. 306 411 **Clerodendron serratum.**

Tall. L. ell. acuminate or lanceolate 2—4″ with cuneate base. Fls. blue (283). 307 413 **Caryopteris.**

Large sarmentose, hoary tomentose, usually climbing (see 433). 308 414 **Symphorema.**

Large erect white tomentose. L. crenate ell. or ell.-oblong 4—8″. Fls. small in panicled spikes. 309 416 **Colebrookia.**

Shoots herbaceous. L. ovate acute coarsely crenate, lower 4—5″ very aromatic (527).	310	415	Pogostemon.

(2) Leaves without distinct glands beneath (abundant on the inflorescence in 311).

Usually an undershrub. L. sessile 6—10″ narrowed to a cordate base. Fls. blue.	311	382	Strobilanthes.
Usually sarmentose. L. nearly glabrous, lineolate, ovate 2—6″, decurrent at base.	312	380	Petalidium.

** Leaves palmi-nerved.

† Leaves with glands on lower surface (or obscured by pubescence in 313).

Sarmentose shrub (see 284, 297, 305).	313	410	Clerodendron phlomoides.
Erect, bushy. Branches fulvous-hairy. L. 4—8″ ovate, often cordate, serrate or denticulate, very rarely entire. Petiole 1—4″.	314	412	Clerodendron infortunatum.

†† Leaves without glands (often dotted with cystoliths).

L. with 3 strong equal basal nerves, ovate 5—10″, coarsely toothed.	316	483	Bœhmeria.

B. Leaves alternate.

§ Margins of leaves quite entire.

* Leaves penni-nerved or venation obscure.

† Juice milky. Fleshy shrubs (see also young plants of 57).

Branches quill-like, unarmed. L. very small, caducous.	316	432	Euphorbia Tirucalli.
Branches stout with pair of stipular prickles. Stem single 4—6 ft.	317	434	Euphorbia nereifolia.

Branches stout with pairs of stipular prickles at tip. Stems several from root 3—4 ft.	318	435	Euphorbia caducifolia.

†† Juice not milky.

(1) Fleshy jointed shrubs armed with slender spines. L. minute subulate, caducous (Prickly-pears).

Spines one only at each leaf site	319	285	Opuntia monacantha.
Spines several at each leaf site	320	284	Opuntia elatior.

(2) Shrubs with numerous erect unarmed branches clothed with minute leaf scales.

Shrub 2—4 ft. Fls. pink. Seeds with hairs	321	20	Tamarix.

(3) Shrubs with normal leaves (see also Olax, Opilia and Cansjera which are shrubby in the open. Also 117 Cleistanthus which sometimes flowers as a shrub).

(*a*) Armed with thorns (see also 333).

x L. aromatic with pellucid glands, rarely entire, see 67, 68, 151—153.

xx L. eglandular.

Branchlets rusty tomentose. L. 1—2·25″ pubescent (97).	322	317	Diospyros Chloroxylon.
Branchlets pale. Smooth. L. 1—3″ glaucous beneath.	323	446	Flueggia.

(*b*) Unarmed. Leaves glandular or scaly beneath.

x Numerous small red glands on under-surface.

Shrub 4—6 ft. with angled branches and lanceolate leaves. Small fls. in large folded bracts.	324	188	Flemingia strobilifera.
Shrub 4—6 ft. with large ovate cordate leaves. Small fls., bracts under ·25″.	325	192	Flemingia paniculata.

xx Small round gland-scales on under-surface.

Tall 4—7 ft. L. long and narrow 3—10", sometimes serrulate at tip.	326	455	Homonoia riparia.
Short, much branched. L. obovate to oblanceolate 1—2", entire retuse or toothed.	327	456	*Homonoia* retusa.

xxx Minute red and translucent glands sunk in the leaf margins and on inflorescence.

L. membranous ell. to obovate 2—6". Petiole ·3—·5", Fls. greenish-white (82).	328	312	Embelia robusta.
L. rather fleshy, glabrous, 4—8". Petiole stout ·25". Fls. pink (83).	329	313	Ardisa.

(*c*) Unarmed. Leaves without glands (inflorescence with stalked glands in 340 Plumbago).

Large. L. coriaceous (No. 322, 97)	330	317	Diospyros Chloroxylon.
Large. L. thin 1—2" rarely 3" distichous, pale, tertiary n. reticulate. Fl. pedicelled.	331	446	Flueggea.
Large. L 2—4" distichous, glaucous beneath, tertiary n. nearly straight. Fl. sessile.	332	437	Bridelia Hamiltoniana.
Sarmentose, rarely with stipular thorns. L. ·5—1·75 pinnately arranged, obtuse or rounded both ends.	333	442	Kirganelia.
Large. L. 2—5" obovate-lanceolate or narrow ell. acute. Fls. spicate (93, 113).	334	449	Antidesma diandrum.
Large. L. 2—4" oval obtuse. Petiole ·17—·5". Fls. spicate, spikes panicled.	335	448	Antidesma Ghæsembilla.
Erect gregarious along river banks. L. ·25" pinnately arranged.	336	441	Phyllanthus Lawii.

Large. L. 1—1·6″ oblanceolate to cuneate-obovate, few on a twig.	337	78	Erythroxylon.
Large. L. oblanceolate 1—4″ varnished and somewhat aromatic.	338	131	Dodonæa.
Sarmentose. L. clustered 1·5—3″, often with opp. circinate tendrils below.	339	77	Hugonia.
Sarmentose. Branches green. L. 2·5—3·5″ ovate or ovate-oblong narrowed into a short amplexicaul petiole.	340	311	Plumbago.
Twiggy with small obovate fascicled leaves ·25—1·25″ (349).	341	363	Ehretia microphylla
Twiggy, along river-beds, branches very tough. L. linear to oblong-oblanceolate ·5—1·25″.	342	364	Rhabdia.
Stems slender erect strict. L. linear or oblong 1·5—3″ with thin brown hairs.	343	142	Crotalaria juncea.
Garden shrubs with brightly coloured or variegated leaves.	344	452	Codiæum Acalypha.
** Leaves palmi-nerved. Branches with stipular prickles.	345	112	Zizyphus Jujuba.

§§ Leaves deeply 2-lobed at the apex, palmi-nerved. Lateral margins entire.

Large. L. 2—3″ split nearly half-way down. Hairy beneath. Fls. white.	346	225	Bauhinia tomentosa.
Large. L. 2·5—7″ often split, more than half-way. Fls. purple.	347	229	Bauhinia purpurea.

§§§ Margins of leaves not entire.

* Leaves penni-nerved.

Large, usually spinescent. L. coriaceous, sub-sessile, roundish, crenulate 1—3″.	348	109	Gymnosporia.

L. obovate obtuse scabrous ·25—1·25″ margin lobulate crenate or apex 3—5-toothed.	349	363	Ehretia microphylla.
L. narrow, often serrulate towards apex. River-beds (326).	350	455	Homonoia riparia.
L. short obovate, toothed at the apex. River-beds (327).	351	456	Homonoia retusa.
L. linear-oblong. River-beds (342)	352	364	Rhabdia.

** Leaves palmi-nerved.

† Shrubs with stipular prickles.

Branches long, tomentose L. 1·5—3″ tomentose beneath serrulate.	353	112	Zizyphus Jujuba.
Branches slender divaricate, zigzag. L. ·5—1″ with short grey tomentum beneath apex often with few large teeth or serrulate.	354	113	Zizyphus rotundifolia.

†† Unarmed.

(1) Margins of most leaves deeply lobed (exc. sometimes 359).

Branchlets stout. L. with stipitate viscid glands on margins and stipules.	355	451	Jatropha gossypifolia.
Branchlets stout. L. 4—6″ diam. glabrous	356	450	Jatropha Curcas.
Tall sub-herbaceous 6—15 ft. L. 6—12″ diam. Cult. (castor-oil).	357	457	Ricinus.
Stems many erect 3—5 ft. L. variable, upper small lanceolate lower 6—10″ nearly glabrous, base often 2-glandular.	358	459	Baliospermum.
Bushy 3—5 ft. stellately pubescent. L. roundish to broad ell. 4—8″.	359	62	Grewia abutilifolia.

(2) Margins not deeply lobed (exc. sometimes 360—364). Hairs stellate.

Stems usually several 1—3 ft. L under 4" roundish to oblong or obovate usually with cuneate base and rounded apex.	360	65	Grewia sapida.
Stems usually several 1—3 ft. tomentose all over. L. lanc. to ovate-lanc. or oblong, suddenly acute or acuminate, green beneath. Peti. under ·2".	361	60	Grewia hirsuta.
Sarmentose. Stems 3—4 angled below. L. oblong 2—4" green beneath.	362	61	Grewia flavescens.
Erect. Branchlets hoary. L. white beneath lanceolate 2—4". Peti. under ·25".	363	67	Grewia Rothii.
Erect 3—6 ft. L. green ovate-lanceolate sub-cordate, lower up to 6" softly hairy both sides. Peti. ·5—2".	364	69	Triumfetta pilosa.

II. Leaves with 2 leaflets.

Large, very thorny, shrub with grey green foliage (188).	365	81	Balanites.

III. Leaves with 3 leaflets.

A. Leaves opposite, digitately 3-foliolate.

Large, aromatic shrub. L. 3—5-foliolate. Lflts. lanceolate entire or crenate white tomentose beneath.	366	406	Vitex Negundo.
Rarely flowering as a shrub, see No. 189. L. only pubescent along midrib.	367	407	Vitex leucoxylon.

B. Leaves alternate.

§ Leaves digitately 3-foliolate.

Large shrub. Lflts. ovate to ovate-lanceolate entire glabrous.	368	13	Cratæva.
Scrambling. Lflts. obovate, ovate, or lanceolate, pubescent, serrate.	369	133	Allophyllus.

§§ Leaves pinnately 3-foliolate.

* Leaves dotted beneath with minute, usually red glands.

Tall, scarcely branched 5—8 ft. Lflts. lanceolate 6—11". Petiole long 5—6".	370	190	Flemingia stricta.
Bushy 4—6 ft. Lflts. elliptic 4—5", petiole 1·5—4" winged or margined.	371	193	Flemingia semialata.
Little branched 4—5 ft. Lflts. 2—3", petiole ·25—·5". Fls. capitate.	372	196	Flemingia involucrata.
Branched 3—4 ft. Lflts. plicate 1·5—2·5", petiole ·75—1."	373	191	Flemingia lineata.
Branched 4—6 ft. Cultivated. Branches silky, grooved. Lflts. 1·5—2·5".	374	181	Cajanus.

** Leaves not dotted beneath.

Branches 3-cornered, shaggy. Lflts. with 13—18 strong sec. n. each side.	375	166	Desmodium Cephalotes.
Branches several-angled, pubescent. Lflts. with under 10 sec. n.	376	165	Desmodium pulchellum.

IV. Leaves with 4 leaflets.

See No. 198 which sometimes flowers as a shrub.	377	257	Pithecolobium.

V. Leaves with 5 or more leaflets.

A. Leaves opposite. See Nos. 189, 366, 367.

B. Leaves alternate.

§ Leaves simply pinnate (see also 388).

* Leaves paripinnate.

Bushy 4—10 ft. Twigs and leaves hairy. Lflts. oblong. Stipules large foliaceous.	378	215	Cassia auriculata.
4—7 ft. Twigs and leaves glabrous or nearly so. Lflts. lanceolate. Stipules small.	379	216	Cassia Sophera.
8—12 ft. Lflts. linear-oblong 10—20 prs.	380	158	Sesbania ægyptiaca.
Weak 7—10 ft., branches muricate. Lflts. 20—40 prs.	381	159	Sesbania aculeata.

** Leaves imparipinnate.

† Margins of leaflets entire.

(1) Lflts. with translucent glands.

Handsome shrub with box-like foliage or lflts. 1—3″ ovate to obovate, sometimes notched at the tip, base oblique. Fls. pretty, white (224).	382	82	Murraya exotica.

(2) Lflts. without translucent glands.

Bushy 4—8 ft. Lflts. 13—17, ·75—1″	383	152	Indigofera arborea.
Bushy 2—4 ft. Lflts. 3—5, ·5—1″	384	153	Indigofera paucifolia.
Large sarmentose, ultimately climbing. Lflts. 7—9, obovate-oblong 6—12″.	385	156	Millettia auriculata.

†† Margins of leaflets not entire.

(1) Lfts. with translucent glands.

Strongly scented shrub. Lflts. 9—20 mostly alternate, oblique crenulate (225).	386	83	Murraya Koenigii.

Strongly scented.	Lflts. 5—9, opposite, glabrous, crenulate. Rachis winged.	387	84	Limonia.

§§ Leaves twice-pinnate (or thrice-pinnate in sect.**)

* More or less prickly. Lflts. small, rarely 1″.

† Thorns terminal or axillary.

Thorns terminating the main rachis of a reduced bi-pinnate leaf (241).		388	212	Parkinsonia.
Thorns axillary or terminating the shoots,	short. L. 1—3″. Lflts. ·05—1″ (244).	389	235	Dichrostachys.

†† Prickles stipular.

Prickles short.	Bush with beautifully scented yellow flower heads (245).	390	240	Acacia Farnesiana.

††† Prickles numerous, scattered along the branches and often on rachis.

Erect garden shrub (Peacock flower).	Rachis not prickly. Lflts. oblong ·5—1″.	391	207	Cæsalpinia pulcherrima.
Sub-erect, weak,	with several stems. Pinnæ 6—12 prs. Rachis with many recurved prickles. Pod without prickles.	392	238	Mimosa rubicaulis.
Similar to 392 but pinnæ fewer, 4—8	prs. and pod with aculeate prickles.	393	239	Mimosa hamata.
Scrambling.	Leaf rachis, thinly hairy or glabrescent, not prickly or prickles minute, under ·05″. Lflts. ·25—·5″. Pod short fleshy.	394	206	Cæsalpinia digyna.

Scrambling.	Leaf rachis densely brown hairy with numerous prickles ·05—·1″. Lflts. oblong ·5—1″. Pod dry, beaked with the style.	395	208	Cæsalpinia sepiaria.
Scrambling.	Leaf rachis with numerous prickles and two large foliaceous, often compound stipules at base. Lflts. ovate-oblong ·5—1″. Pod prickly short.	396	205	Cæsalpinia Bonducella.

** Unarmed (see also 262 which often flowers as a shrub). Lower leaves 2—3-pinnate. Lflts. 3—12′ strongly serrate.

Stems annual 5—10 ft.	Lflts. with 1—2 teeth to each strong sec. n., often with scattered erect hairs above, slightly hairy on nerves beneath.	397	127	Leea aspera.
More woody 4—6 ft.	Lflts. with 3—5 teeth to each strong sec. n. Branchlets, rachis and leaves beneath more or less pubescent or hairy.	398	128	Leea robusta.
Woody 4—6 ft.	Lflts. with 3—4 teeth to each strong sec. n. Branchlets, rachis and leaves glabrous.	399	129	Leea Sambucina.

β. Parasitic shrubs (sending roots into the branches of other trees or shrubs).

Leaves O.	Branches often whorled, flattened, contracted at the nodes.	400	430	Viscum articulatum.
L. 1—1·5″, sub-sessile, faintly 3-nerved.	Branches sometimes whorled.	401	429	Viscum orientale.

L. 2—4″. Shoots and leaves covered with white *or rusty* tomentum. Fls. greenish.	402	428	Loranthus scurrula.
L. 3—6″. *Glabrous*. Fls. *showy* red or pink.	403	427	Loranthus longiflorus.

PART III.—PALMS AND BAMBOOS.

I. Palms (a few others are occasionally cultivated).

Tall tree. Leaves large *simple* fan-shaped. Trunk smooth (Palmyra).	404	505	Borassus.
Tree. L. large pinnate 7—12 ft. Lflts. fascicled in *different* planes. Petiole spinous and leaflets spinous tipped. Trunk clothed with petiole bases.	405	506	Phœnix sylvestris.
Shrub. *Stem very short and stout densely* clothed with bases of petioles. L. pinnate 3—5 ft. Petioles with long spines.	406	507	*Phœnix* acaulis.
Shrub, scandent when well grown. Stems slender. L. pinnate 3—4 ft. with 25—30 prs. leaflets. Sheaths armed with flat and hooked spines.	407	508	Calamus.

II. Bamboos (excluding cultivated species).

Culms 2—3″ diam. with very thick walls. Branchlets without thorns.	408	516	Dendrocalamus.
Culms 4—6″ diam. Branchlets below with sharp thorns at the nodes.	409	517	Bambusa.

A SHIKAR INCIDENT.

BY R. ST. G. BURKE, I.F.S.

Somewhere about the middle of April 1914, my wife and I were camping at a Forest Rest-house, in the Lansdowne Division, situated on the bank of a nala at the head of a triangular piece of flat country of some size running up inside the general line of the hills. A road runs north-west from the bungalow up a small hill, over a low pass about half a mile from the bungalow, and down the other side. On the bungalow side of this hill the road is also a fire-line, but this fire-line leaves the road on the other side of the pass, and there is also an inspection path running along the ridge, so that the top of the pass is a meeting place of five ways, a good place for tying up.

One morning our men told us that the bait at this place had been killed by wild dogs, so I immediately went out to it in the hopes of finding some of the brutes still at it. On arrival, however, I found that the kill was undoubtedly that of a panther. The hard ground yielded no tracks, but the kill had not been dragged

(being too heavy for anything but a tiger), it had been eaten by a single animal and not by a pack, and near by there were marks in the sparse grass of an animal having rolled on the ground, a close inspection of which revealed a few undoubted panther hairs attached to the hard jagged end of a cut grass stump. The only thing growing near strong enough to hold a 'machán,' as also the only thing with even dry leaves on it, was a bamboo clump, so I consequently had a 'machán' tied up in this and the kill covered up.

My wife was settled in this 'machán' by five o'clock that evening. The animal was not expected to return to such an open and exposed place till dark, but the ridge rises sharply up from the pass on both sides, and if the panther intended coming back at all he would almost certainly, comparatively early in the evening, take up some position of vantage on one of the two sides whence he would be able to watch his kill for some time before approaching it. An electric light, with the bulb (giving rather a faint light) over the kill and the switch attached to the 'machán,' was provided.

Six o'clock came and went without the slightest sign of life anywhere. At half past six a few vultures, having spied the now exposed kill, wheeled round and round for some time, only eventually to settle in a neighbouring tree ready for the hoped-for feast on the morrow. By seven o'clock the clouds had banked up on the horizon, the low growl of distant thunder could occasionally be heard, the wind started coming fitfully down the nala and across the pass, and it began to be a question whether the storm or the panther would be first on the scene.

By half past seven it had grown dark, and then for the first time my wife heard signs of the presence of an animal. On the hill behind her she heard a slight rustling combined with the soft heavy tread of an animal descending. The animal came slowly and steadily on until nearly level with the 'machán' and then all sound suddenly ceased. Sitting rigid, with rifle at the ready, she waited for further sign, but the minutes grew into a quarter of an hour, and the quarter into a half, without the slightest further sound, and it then became evident to her that the animal must

have been the panther, for no other animal (except perhaps a tiger) would have melted away in complete silence in that manner, that it must have got her scent as it came level with the 'machán,' and that in consequence she had probably been cheated of her prey.

By now the clouds had rolled up, there was an occasional vivid flash of lightning, and the wind had increased. The latter too had become gusty in the extreme, at one time nearly blowing her off her insecure perch in one direction, anon doing the same thing from the opposite side, so that when the half hour had grown into an hour she decided that she had had enough of it and that there was no further chance of the panther turning up, so she put down her rifle and blew her whistle to summon the men and the elephant waiting in the valley below.

After three whistles she got an answer, and then made ready to descend on their arrival. A few moments later, however, a faint moving shadow appeared upon the white road which looked much more like an ordinary sized animal than human beings with an elephant, so she softly picked up her rifle again and waited. The shadow came quietly on until it arrived at the kill, where it stopped. It seemed as though it must be the panther, but the men do sometimes come up silently in this fashion in spite of frequent and emphatic orders to the contrary, and darkness plays weird tricks with shapes and sizes, so to make sure she flicked the electric light quickly on and off again, imitating a flash of lightning.

This revealed the undoubted form of an animal, so the light was turned on again and a hasty shot taken. At the shot the animal bounded off into the darkness down the fire-line away from the camp without uttering a sound, and my wife was left in considerable doubt as to whether she had scored a hit or a miss. Then—from within a hundred yards—the men gave a whistled query, and were told to come on cautiously on the elephant, which they did, the whole party reaching camp without further incident.

The storm passed off without giving rain after all, and my wife and I sallied forth early next morning on an elephant to

investigate. A few yards down the fire-line we found a spot of blood, and thirty yards further on there lay dead, with a couple of vultures sitting in a tree over her evidently wondering when it would be safe to venture down, not a panther, but a fine tigress. She lay head pointing uphill, her front paws stretched out above her, and her hind legs braced underneath her body as though she had been trying with her last strength to prevent herself from slipping downhill. Above her were the marks of where she had first come to ground and then slipped down to her final position. She had licked her wound, and then, in her death agony, had bitten at the grass and earth around her.

This yarn—which is absolutely true in every detail—presents a most extraordinary instance of the tricks of Dame Fortune in the matter of shikar. In the first place, had the panther not become suspicious, it would have been shot and there would have been no one in the 'machán' when the tigress came along: in the second place, there was the extraordinary luck of the tigress happening to go that way at all: in the third place, there was the accurate timing necessary for the tigress to cut in on to the road from the jungle and to arrive at the kill after the men had been called up and before they could come so close as to frighten her away, it being borne in mind that they were originally only three or four hundred yards away.

But most of all there was luck in the matter of the particular animal which had been killed, for there was only one tigress which haunted these parts in those days, and she was an animal of extraordinary cunning. She lived in the hills, in places quite inaccessible to a line of elephants, and was always quite ready to kill any bait tied up, but never returned to a kill. In fact, although she always dragged her prey away from the scene of the actual kill, she never even used to take the trouble to hide it, but would simply eat what she could during the night and leave the rest to the hyenas, vultures and jackals after the disappointed sportsman in question had done with it. One also used to notice that even if she were not to the fore when one first came within the area of her beat, yet she seldom failed to turn up within a day or two,

and then always remained in evidence until one left again. Possibly she might have been trapped by sitting up all night over a live bait, but it is certain that this had been tried several times by various sportsmen without success. She may not have come round on any of those occasions of course, but, on the other hand, it is quite possible that she was in the habit of making sure that no one was in any of the neighbouring trees before taking any tied bait. The number of baits she took in the course of her career is not known, but it must have been considerable, and included a good many of our own. And yet she was never a cattle-killer in the ordinary sense of the term, so that it would almost seem as though she only took what was deliberately offered.

EXTRACTS.

Extracts from Punjab Forest Conference Report, 1915.

THE DEODAR.

BY C. G. TREVOR, I.F.S.

I.—GERMINATION OF THE SEED.

Deodar seed commences to ripen early in October, depending on the elevation and situation of the tree, and by the end of November or the middle of December the seed has all fallen. Germination commences in the spring as soon as the snow has melted away, in warm situations in February, and continues to April by which time all the seed should have germinated. The seed germinates regardless of its environment and under all conditions of light and shade. It has been found germinating even on stones and under the snow. After any good seed year thousands of seedlings are found everywhere, of whom only a few eventually survive. From observations made in the spring of 1913 it is evident that there is no difficulty whatever about germination, and that it is obtained under every sort of condition found in the forests. In support of this statement it will only be necessary to quote a few instances observed after the good seed year of 1912. In Paneo forest on an open maidan, 100 by 50 yards, a profuse crop of seedlings germinated. In Phetaban under a dense crop of deodar with a few kail and fir, which had been thinned in 1911, complete reproduction took place. Again in Talata, under a crop of large fir trees, reproduction of the same year established itself. In 1913 some deodar seed was sown by mistake under the shade of yew trees, and even this germinated well. These authenticated instances suffice to prove the correctness of this statement. Figures have already been produced before the Punjab Forest Conference which show that in a good seed year the supply of seed-bearers of all sizes is amply sufficient. The ratio of seed-bearers to barren

trees over 6 feet in girth was found to be 3·5 to 1, and in trees from 3 feet to 6 feet in girth 3·2 to 1. Trees growing isolated in fields frequently produce some seed nearly every year and in a good year are loaded with cones. On the other hand, trees growing in a dense canopy or in cold high situations produce very little seed even in a good year. The frequency of seed years is not constant and the extent of the seed crop varies considerably; 1912 was good, 1914 partially good, 1913 and 1915 were uniformly bad. The fertility of the seed has also been tested, and the old fallacy that large trees do not produce fertile seed exploded. It has been shown by Mr. Parker that trees up to 10 feet girth produced 98 per cent. of fertile seeds. From observations recorded in Sandhar in 1912 it is certainly true that a good deal of bad seed is produced by very old trees, but sufficient good seed was also produced; and contrary to the opinion expressed in the working-plan the age of the mother trees can have had no appreciable effect on the absence of reproduction; indeed where circumstances were favourable, natural reproduction of 1912 has established itself. It, therefore, appears that ample fertile seed is produced by all classes of trees, that given a certain minimum amount of moisture germination in profusion is certain, both under shade or in the open, on solid clay or in deep humus, and that the absence of reproduction can in no way be due to bad seed or faulty germination. A reference to nearly every deodar working-plan will show that ample germination takes place after every seed year, and the writers generally add that most of these seedlings subsequently perish. It will be endeavoured int he course of this paper to trace the causes of this mortality and to suggest means whereby sufficient reproduction may be obtained in all such places when this is desired.

II.—THE YOUNG SEEDLING.

After germination has taken place the life of the young seedling is beset with many difficulties. In the first place, many thousands fail to get their roots into the soil, either owing to a

dense layer of matted grass, to germination having taken place on stones or tree stumps, or to the presence of quantities of felling refuse. In these cases a few days of hot sun soon put an end to the seedlings' brief existence. Having obtained a footing in the soil, fresh vicissitudes are encountered. Hailstorms either cut the tender seedling in half or strip off its leaves, in both cases causing death. There is a biting insect which severs the stem of the seedling, and from this cause alone the whole of the reproduction in Dunkra Muil in 1914 has been destroyed. A most frequent cause of death is the excessive amount of humus often found in the forests. This substance absorbs water like a sponge, but dries out quickly, so that seedlings growing in it are unable to get their roots down to a permanent water-supply and consequently perish (Bindraban R. 1915). This is the reason why seedlings are so often found growing on road-sides or other places where the mineral soil has been exposed, while they are absent in the forest. Excessive damp or shade also causes the death of seedlings as has been proved in Mulagthana forest where seedlings germinating near yew trees have all died. If the seedling has overcome these dangers and remained alive until the first rains break, its chances of survival are much increased, but even still many perils have to be encountered. The danger of drought in September and October will account for many losses. One of the greatest enemies of the seedlings is the Cockchafer grub which has been found to be the cause of many mysterious deaths ; vigorous healthy seedlings up to 1½ years old have been killed by this pest, which has been caught in the act of eating the roots. We will now suppose that a year has passed, and that the seedling is still alive ; it will be found growing almost regardless of its environment, that is to say, it will be found existing under all conditions of light and shade ; growing in grass right in the open or under the heavy shade of deodar and sometimes fir ; it seems to tolerate even the dense shade of chestnut and oak trees. A difference will, however, be noticed between those seedlings in the enjoyment of light and those which are in shade. The former have put on a good growth after germination, while the latter are stunted and look as if they would not long survive.

Their appearance forecasts their end, for if not opened out and given the minimum light they now require, they gradually fade away and die, or else become the miserable stunted shrubs so often met with. It has been shown that given access to the soil, and a sufficiency but not excess of moisture, germination and subsequent growth up to a certain point is certain; and there can be no question that if sufficient light be thereafter given, and no calamities overtake the young seedling, future development is assured. Other factors, not before mentioned, have an influence on the success or otherwise of the reproduction in any given forest. These factors have already been discussed by Mr. Coventry in his paper at the 1913 and 1914 Conferences, and while admitting the damage done by grazing and trampling, the presence of undergrowth and matted grass and other minor causes, he came to the conclusion that in many cases the soil had become chemically or physically unsuited to deodar and ascribes this to the presence of organic constituents due to humus and vegetable débris. In Sandhar a typical instance of a forest containing plenty of seed-bearers, admitting sufficient light to the soil and with no grazing, reproduction was completely absent. In 1912 the area was cleared of rubbish, bushes and felling refuse, all of which was burnt and seed was sown, both in these burnt patches and in lines. In both places the seedlings are doing well, although in the burnt patches they are much better than in the lines. While hesitating to believe in any theory of chemical change in the soil, I am convinced that the physical state of the soil is of the greatest importance, and that in many instances which may be due to the continual trampling of animals, excess of humus, absence of sufficient light and other causes, this physical state has become unsuited to successful reproduction. I believe that investigation and growth of the sál seedling have demonstrated the importance of the physical as opposed to the chemical constituents of a soil; and a recent writer on Teak in Madras has stated that the absence of natural reproduction of this species is due to the unsatisfactory physical condition of the soil. This theory is borne out by the results obtained by burning felling refuse and sowing seed in the ashes mixed with soil, the results of which

operation are most promising. It therefore follows that the factors enumerated below must be suitable :—

(*a*) Physical condition of the soil.

(*b*) Moisture.

(*c*) Light.

(*d*) Protection.

The measures to be adopted to deal with all these factors will be dealt with later in their proper places.

III.—Sylvicultural Systems in Practice.

(*a*) *Selection Method.*

I now propose to deal with the various methods in which deodar forests can be managed, and before entering into details would earnestly reiterate that, owing to the enormous differences in the physical characteristics of the forest and of the composition of the forest crop, no one method of treatment suitable to all deodar forests can be advocated. There has been an attempt to do this in the past. The Selection method was prescribed in all the earlier working-plans. This was modified into the so-called Selection in Groups, and the Chamba working-plan has introduced the Group method in certain selected forests. There has later been a tendency to advocate the latter system as suitable for employment everywhere. I would entirely dissent from this view, and would urge that each type of forest should be treated in the way most suited to its sylvicultural requirements, combining all the local knowledge available with the experience gained in other localities so as to evolve a scheme of working which will ensure the necessary reproduction, admit of the working of the forests in the most scientific way possible, and produce the greatest permanent revenue. Under the true Selection system every age-class should be represented on every acre of forest in their proper proportions, so that on the removal of the limited number of mature trees the forest would look very much the same as if no felling had taken place. It is also essential in this system that middle-aged trees which have grown up under the shade of the mature stems should be able when finally opened out to grow into mature stems

of the same quality as those removed. Deodar forests of this class are never met with. The Upper Ravi forests mostly consist of isolated deodar growing along spurs in the midst of a mass of fir, or in the best of the Bandal and Tisa forests almost pure deodar approximating to even-aged forests. The Kulu forests contain either a crop of mature trees growing among a large number of II and III class trees, where no reproduction is required ; canopied I class trees with or without advance growth ; or where fellings have taken place, an open crop of II class trees or an even-aged wood of poles. In practice the prescriptions of the working-plan leave little or no scope for the practice of sylviculture, the markings becoming merely the removal of nearly every I class tree found in the forest. An excellent article showing what are the advantages and disadvantages of this method will be found on page 396 of Fernandez' Indian Sylviculture. A perusal of this will show how our present management differs from true selection management, and most forest officers will no doubt agree with the correctness of the signal disadvantages pointed out by the author. The removal of trees in groups instead of singly, with a view to obtaining better reproduction, "the so-called Selection in Groups" has most of the above disadvantages. It can only be applied in the case of groups of mature trees, as otherwise II and III class have to be sacrificed, a matter not taken into account in the arithmetic of our working-plans. Under this system reproduction may be induced which later on without the sacrifice of immature trees it will be impossible to save. In more than one instance the result of our working has been to produce a young crop of deodar growing under an incomplete canopy of II class trees. In such cases either the II class trees must be sacrificed and the reproduction saved, or the II class trees retained to maturity and the reproduction left to be suppressed. Such a position is most unsatisfactory. Deodar tends to produce even-aged woods, the life history of the seedling and the light demands of the sapling all point to this, and in spite of the fact that even-aged forests are far easier to manage in every way, we are still attempting to make the forests more irregular than they were to start with.

Mr. McIntire states in a note I have of his regarding our working-plans :—"It is one thing to cut out mature trees here and there, over an existing advance growth of deodar, and quite another thing to regenerate a canopied mature deodar forest under which there is no reproduction. If, in the latter case, we trust to fellings prescribed long in advance, reproduction must be matter of chance."

Although the position of affairs is serious, and although a decrease in the yield is certain, there is still time to recognise the error of our ways and casting aside the old working-plans formulas of the numbers of I and II class trees, the time taken for a II class tree to grow into a I class, to concentrate our attention on some system based on a knowledge of sylviculture. Instead of fixing the exploitable size on the mere assumption of one man, let it be fixed on pure facts about which there can be no doubt. Fortunately for ourselves during the past 30 years the fellings have largely consisted in the removal of surplus large trees. These have now mostly gone, and often in their place an even-aged crop of trees occupies the ground. Now is our opportunity; either these crops are to be hacked up under a Selection system, regenerated properly contrary to the precepts of this system, and in defiance of the principles of the working-plan, or managed under a scientific system of forestry for the production of even-aged crops and fully stocked woods. The above remarks more especially apply to the Kulu Division. I do not in the least wish to lay down any dogmatic theory of management, but only to urge the importance of a system based on the sylviculture of each different locality—a real sylviculture where we may know exactly with what object we are working and what the results of each action will be; not a hybrid system which may mean anything, under which we are groping in the dark, ignorant of the results of our actions, a system which leaves everything to chance.

I will now consider a few aspects of the *Selection and Selection* in Group systems in practice. Formerly nothing more was done other than the extraction of mature timber. All felling refuse

was left lying on the ground, suppressed advance growth was not removed and very little, if anything, was done to ensure that reproduction followed the fellings. In spite of this neglect in many cases Nature has been kind and reproduction has eventually been obtained; but in many others nothing has come up. Nevertheless, even in the former cases, many years have been lost. Lately, more attention has been paid to this subject, measures have been taken to dispose of the felling débris and the trees are generally now removed with some regard to the question of reproduction where this is not already present on the ground.

Fig. 1 (Plate 8) shows Selection in Groups in Kotadhar forest of Outer Seraj. The trees have been felled and removed, leaving a gap 60 x 40 feet in which all worthless advance growth has been cut out, felling refuse collected and the whole burnt. The gap is now ready for the reception of seed. In the background the rest of the forest properly thinned out will be seen.

Fig. 2 (Plate 8) shows another example in the same forest; a clear gap has been felled, and in the background owing to the removal of I class trees the crop tends to exhibit somewhat the characteristics of a seeding felling.

(*b*) *Group Method.*

This method is the logical sequence of the Selection in Group method. If the latter is good, the former must be better, as under it the exact areas to be regenerated are specified, all felling operations are carried out to this end, and concentrated attention has to be paid to the areas in the first periodic block. The fellings shown in Figs. 1 and 2 (Plate 8) are practically Group fellings, such as would be made under the above method. There can be no comparison between the true Group method and the hybrid called Selection in Groups. Every advantage that can be claimed for the latter is posssesed by the former, and in addition the great advantages of concentrated regeneration areas, a fixed rotation and regular more or less even-aged crops. Considerable skill is of course essential to correctly carry out this method, but we can hardly plead against the adoption of a scientific system of

Sylvicultural Operations in Deodar Forest.

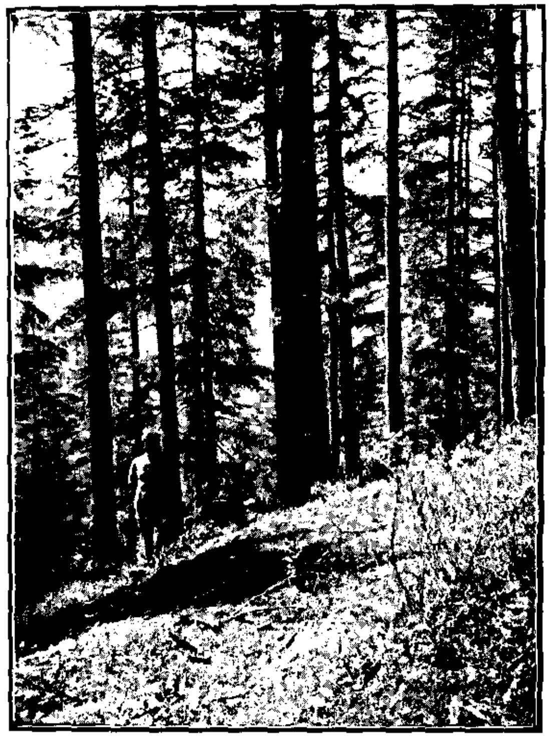


Fig. 1.

Fig. 2.

Fig. 3.

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forestry that we are devoid of professional skill or ability. The Pabar and Chamba forests are now being worked under working-plans prescribing this method of treatment.

(c) *Regular or Shelterwood Compartment Method.*

So far no attempt has been made to work deodar forests in India under this method, but its feasibility was recognised even in 1888. Mr. Fernandez in his *Sylviculture* states that this system is most suitable for deodar, provided the gradients are not too steep. The great disadvantage of this method quoted by him is the impossibility of disposing of all the produce to be removed owing to the inadequate demand of those days. This condition no longer applies to Kulu where everything can generally be disposed of. The author enumerates clearly the advantages of this system, pointing out its simplicity as compared with the difficult Group system. A perusal of this article founded as it is on the " Waldbau " of Dr. Karl Gayer is recommended.

The method in question has already been applied to Chil in the United Provinces with success and is being introduced into Chil forests in the Punjab, It appears to have very great advantages and to demand the serious attention of future Working-Plans Officers. In a country like Kulu the system presents no difficulties which cannot be surmounted with ease. From the facts already brought to light in this paper or hereafter mentioned, the importance of even-aged woods, definite areas under regeneration, tending of the seedling and its demands on light, all point to the adoption of this system of management. It is quite unnecessary to regenerate large areas together; an innumerable number of felling-series can be adopted under which closing to grazing and the provision of trees for right-holders may be easily met. It is difficult to see what objections can be urged against this method, except the objection that its working will be complicated and require constant attention and effort on the part of the establishment from the Divisional Officer down to the Forest Guard. But after all this is the purpose for which we exist. By spreading the felling-series over the whole Division, it will be

possible to utilise the establishment and keep them fully employed on necessary forest works. The local Ranger will have ample opportunities of practising sylviculture, the local guard will be well occupied in weedings, minor improvement fellings, cleanings and all the operations necessary for the tending of young crops. The system will produce even-aged fully stocked woods putting on the maximum annual increment in which systematic cleanings and thinnings will be duly carried out. The final crop will consist of long clean stems grown to average the correct size found to be most profitable and producing a very large revenue per acre. Fig. 3 (Plate 8) and Figs. 4 and 5 (Plate 9) show seedling fellings carried out in deodar crops.

IV.—REPRODUCTION.

The Tending of the Seedling.

Having discussed the various methods of management in practice, it now remains to consider the means to be taken to ensure successful reproduction under any of the systems employed. The life-history of the seedling has already been discussed in Chapters I and II and need not again be referred to. In the latter chapter it has been stated that four factors are essential for the successful reproduction of deodar, and I will now deal with the measures required to ensure that these factors be favourable.

(*a*) *Physical Condition of the Soil.*

It may be safely said that an excessive deposit of coniferous needles is inimical to regeneration, and most authorities admit this. The seedlings will germinate in this medium, but cannot survive the hot weather in May and June, and invariably succumb. This excessive vegetable deposit must be dealt with ; it will have been broken up to certain extent by the felling and removal of timber which has just taken place ; it will be still more reduced by the collection and burning of felling refuse, which is generally essential to proper management. If still excessive, it may be raked up and burnt or hoed up and mixed with the soil. The rubbish is raked

Sylvicultural Operations in Deodar Forest.

Fig. 4.

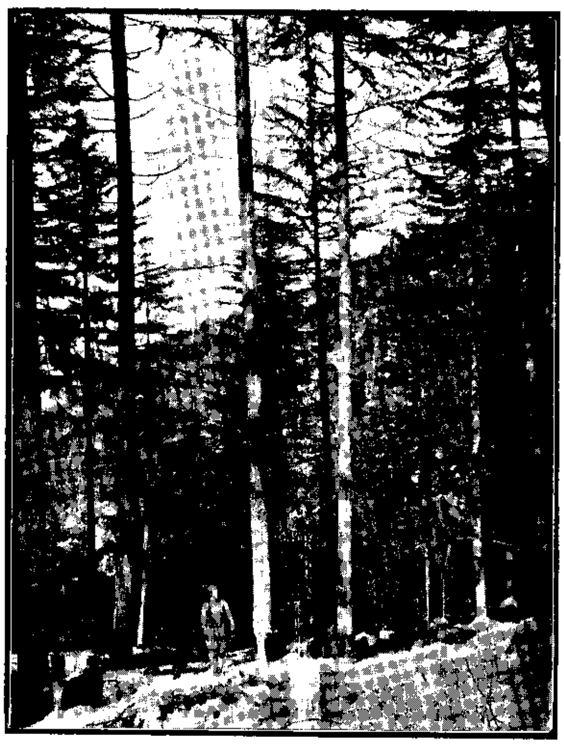

Fig. 5.

Fig. 6.

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into heaps with iron-pronged rakes which have the effect of wounding the soil, and the burning of the heaps considerably reduces the deposit of humus in their vicinity. So that after this operation is complete, the soil mixed with the ashes of the burnt heaps is generally in a suitable condition for successful reproduction. Cases may occur where, owing to an open canopy, there is a thick growth of matted grass or brushwood. These conditions should not of course exist, but in the present state of the Punjab forests they frequently occur, and when combined with heavy grazing, result in a total absence of reproduction. In such cases hoeing of the ground combined with closure to grazing, so as to avoid the trampling of cattle, and ensuring that sufficient seed gets into the ground will generally have the desired effect. Continued observation has convinced me that under certain conditions, which I am unable to specify, a time arrives when the condition of soil in an old deodar forest becomes quite unsuited to reproduction and that in these circumstances natural regeneration will not be obtained These forests have usually been exploited and contained a more or less broken crop of over-mature trees. The soil covering is a dust-like refuse of old needles which supports the growth of a few weeds. This state occurs in many forests. The experienced eye will have no difficulty in detecting such conditions which are quite characteristic. The vegetation found on the ground will also indicate the quality of the soil. The shrub *Plectranthus rugosus* is invariably a bad sign. In such cases the burning of refuse together with the soil covering and the thorough mixing of the ashes with the mineral soil may be expected to have satisfactory results, as indeed has happened in practice, considering the way deodar has spread over areas open to grazing, and every other right it should not be difficult to take such measures as will rectify any tendency of the soil to become unsuitable for successful reproduction. It must be noted however in these cases where nature has succeeded that in many instances a considerable period of years has elapsed; that time is of no importance to nature, and consequently that no Forest Department can afford to work on these lines.

(*b*) *Moisture.*

It has already been pointed that thousands of seedlings die of drought. In practice it will be found that this mortality is very largely due to the seedling germinating in a thick layer of humus, and this aspect of the case has already been fully dealt with or directly under the shade of the parent tree. Under normal conditions of weather deodar is quite capable of thriving right out in the open without any canopy at all. Instances of this are common.

The year 1915 has been a good one for observing the effects of drought on the young seedling. There has been general mortality of seedlings including some of those of 1912, but it is emarkable that seedlings growing under the shade of parent trees have suffered more than those more or less in the enjoyment of ample light. If an examination of the ground after a heavy shower of rain is made, it will be found that under the shade of a deodar tree the ground is quite dry. Seedlings suffer more from drought under the shade of the parent trees than in the open, and I hold that the prevailing idea of deodar requiring shade, shade being taken to mean the shade of the parent trees, is altogether wrong. I admit the value of the shade of grass and low weeds and shrubs which do not prevent the rainfall reaching the seedling and which also collect the dew, in fact I consider them in many cases indispensable to success, but I cannot admit that an overwood is indispensable except for the purpose of producing seed and by its shade keeping the undergrowth within manageable dimensions.

Again, excess of damp is fatal. In practice it is of course impossible to regulate, except by indirect means, the supply of water to the seedling; we must submit to the calamities of droughts, hail and other vicissitudes of fortune. It will be sufficient to endeavour to regulate matters by means of the density of the canopy, the condition of the soil and other means at our disposal.

(*c*) *Light.*

A reference to Chapter II will show that deodar germinates nd exists during the first few years of its life under all conditions

of light and shade, but that in the case of seedlings growing in shade a time comes when it is essential that plenty of light and air be admitted, if a healthy young crop is desired. I now propose to give a few instances of the effect of light on development from actual observations :—

(*a*) A gap clear felled in Bajraundi forest during the rains of 1912 measuring 3,680 square feet. These trees were all malformed and were removed before the fall of the seed. Fenced in spring 1913 when hundreds of seedlings germinated. The seedlings are most flourishing and up to 10 inches in height. Weeded slightly in rains of 1914; otherwise nothing done.

(*b*) Seedlings of the same age from Phetaban which have grown under complete canopy of deodar are 2 inches to 3 inches in height. In order to preserve this young growth the canopy has been largely removed.

(*c*) Seedlings of same age growing in a burnt patch in the full enjoyment of light in Sandhar forest are 14 inches in height.

(*d*) One-year old seedlings from Kasol growing on land burnt in 1912 in the full enjoyment of light, 10 inches in height.

The difference in development sufficiently proves that ample light is most beneficial to the seedling, and that it can thrive without any overwood at all.

Innumerable instances can be given of the influence of light on growth. In the Jutlikalwala plantation the height of deodar growing in the full enjoyment of light was double that of plants growing under only a light overwood of Kail. In Trai Jakar plantation deodar plants 7 years old, growing under a heavy overwood of Kail, are not yet 2 feet high, and this year's leader is not more than 2 inches long. Many of these plants are already dead or have become hopelessly suppressed.

Light may be admitted to the ground either directly by clear felling the canopy in groups as is being done in Chamba and as practised under Selection in Group method, or by allowing it to

filter through an incomplete canopy of mother trees. Side light appears to be very valuable; in forest facing west the side light from the south appears to have excellent results on reproduction. Instances are known in which the centre of a clear felled gap is bare of reproduction, while the edges are covered with it. The presence of a shelterwood protects the young seedling from hailstorms, keeps down the growth of weeds and prevents excessive baking of the soil, which might occur in the case of a large gap. The difference in the two methods as regards the admission of light to the soil is for the present, at any rate, of minor importance.

From the foregoing facts it appears that an ideal method of regenerating deodar (especially applicable to Kulu and other forests on easy ground) is to regenerate on the principles of the regular method under a moderate shelterwood and to rapidly remove the same as reproduction is obtained. Under this method a mixture of deodar and Kail can be obtained with the greatest ease. It is only necessary first to admit sufficient light for the reproduction of deodar and thereafter, when sufficient has been obtained, to make a heavy felling, retaining a few Kail as seed-bearers, when complete reproduction of Kail will be obtained. This has actually happened in practice in more than one instance.

(*d*) *Protection.*

It has already been proved that goats are most destructive to all forest growth. These animals should therefore be, as a matter of course, excluded from areas under regeneration. Several Forest Officers have also pointed out that the grazing of horned cattle is often of advantage; there can, however, be no doubt that in certain cases extensive grazing is the cause of mortality among thousands of seedlings, and in fact this damage may be so severe as to entirely destroy the whole crop.

In the spring of 1913, when the experimental area in Bajraundi was closed and fenced, there were thousands of seedlings both inside and outside this area. Those inside still persist and are in a most flourishing condition, while outside under exactly similar conditions of soil and light nearly all have perished.

The damage done by grazing is chiefly dependent on the extent to which it takes place. If only a few cattle graze, their presence need not be considered, but where large herds are every day driven over the regeneration area, they are most destructive and their presence cannot be tolerated. Nature can afford to wait for years to regenerate an area, but every year is to us a matter of importance. It may, therefore, be accepted that grazing may be permitted up to the commencement of regeneration, and thereafter should, as far as possible, be excluded from the regeneration area.

Damage may also be done by various wild animals, birds and insects, but little can be done to mitigate these attacks, and I shall not now discuss them.

Natural reproduction of deodar should not be difficult to obtain under a sound system of management in which the areas under regeneration are specified and where proper measures are taken to carry out the necessary works mentioned at the commencement of this chapter, and any others which may be necessary to ensure that the essential factors are favourable. After any good seed year such as 1912, millions of seedlings are found everywhere throughout the forests and there should be no great difficulty in preserving these where we require them. At present under our Selection system nothing is, as a rule, done to ensure reproduction, a felling is marked, the trees are felled and nothing more done. Under these circumstances, it is mere chance whether reproduction is obtained or not. Working-plans state that reproduction is bad, quite regardless of whether reproduction is wanted or whether the canopy and other factors are suitable for it. In nearly all the cases in which the cry "no reproduction" has been heard, no sustained efforts have been made to obtain it.

In some cases the assistance of artificial works are necessary. I am not going to discuss the various methods of making plantations or the respective advantages of sowing and planting. This is a separate subject, with which, for the present, I am not concerned. The text-books deal fully with this operation and all matters connected with it. Nevertheless, a great deal of useful work can be

done at a small cost to assist natural reproduction either with the object of introducing a different species or of supplementing the supply of seed from the existing mother trees.

Having obtained a sufficiency of seedlings on the ground, it is now necessary that they should be tended. This work has always been considered necessary in plantations, but in forests worked under our Selection system nothing of this sort is usually done. This tending may be divided into two operations—(*i*) weedings proper which consist in the removal of herbaceous growth choking the seedling, and (*ii*) what I call minor improvement fellings consisting in the cutting of shrubs and malformed advance growth which is hindering the development of the young crop. Both these operations have been found essential to the successful rearing of a new generation. Where the canopy has been opened up to the extent required for the growth of the young deodar and the area has been closed to grazing, a crop of weeds and long grass is a certainty, and for a few years it is necessary that rough weedings be carried out. It has been found that young deodar tolerate a good many weeds, but where they become surrounded and overwhelmed with rank growth they are apt to become attacked by the fungus "Peridermium Cedri." In addition to the crop of weeds which are bound to spring up, the light required by the deodar crop is also sufficient for the growth of various shrubs—Indigofera, Berberis, Prinsepia, etc., all of which should be kept down. In the ordinary Selection worked forest there will probably be found Rhododendron, Yew, Pieris and a variety of broad-leaved trees which are doing the new crop no good and which should be removed. This is the operation which I call Minor Improvement fellings, and these two operations—Weedings and Minor Improvement fellings—duly carried out will see the seedling safely through the early years of its existence, until it reaches the sapling stage and requires the operation described in the next chapter.

V.—CLEANINGS.

This operation consists in thinning out dense crops of saplings more or less even-aged and of equal height growth. Cleanings

are in reality thinnings in young crops where the produce removed is of no value and cannot be sold. Trees over 6 inches diameter are of some value and can generally be sold; they are removed in thinnings. The problem of dealing with large areas of young crop is no easy one; it is essential that they should be thinned so as to develop good healthy stems with crowns of sufficient vigour to withstand the snow. It is certain that cleanings should commence early, and continue at regular intervals, until the crop reaches the thinning stage. In unthinned crops with long slender stems snow-break is a very real danger which is aggravated as soon as thinnings proper come to be made. Many crops have been almost ruined owing to the neglect of cleanings in their early youth; and it is therefore plain that thinnings or rather cleanings should commence at a very early age and should continue at regular intervals throughout the life of the crop. In the case of deodar line sowings I commence cleanings when the plants are about 3 feet high or less and cut out surplus plants with a knife, leaving the best ones at suitable intervals. The ordinary Forest Guard does this work. Later on when the young crop is 6 feet or more in height and has covered the ground with a complete canopy, cleanings proper may commence. The question then arises how to get this work done with the establishment available; it is out of the question for the Divisional Officer or a Forest Ranger to do this work, they have other more important duties to perform. There remain Foresters and Guards. Trained Foresters are required for the marking of thinnings which cannot be entrusted to any untrained men and so the work must be done by Forest Guards or not at all. In the case of even-aged crops of small trees this cleaning work does not present many difficulties. It becomes very much a question of thinning out the stems to so many feet apart, and a method has been devised by which this can be accomplished by any man of average intelligence. It has been found that in these crops under 6 inches diameter an average espacement of 6 feet gives satisfactory results, and in order to obtain this espacement all that is necessary is to order the guard to provide himself with a 4-foot stick and to see that the stick passes between all trees left standing. That is

to say, in cases where the stick will not pass between two stems, one of them must come out. The guard is ordered to retain the best of the two and cut out the other, a simple order which any one can carry out. This method is only mentioned in case other Forest Officers may wish to use it ; the operation described can of course be carried out by eye, but it has been found that adherence to the above orders gives better results than is to be expected from a guard marking by eye and in every way as good results as can be attained by the marking by eye of an experienced sylviculturist. The length of stick can of course be varied at discretion to give closer or lengthier espacement as may be desired. In Kulu the espacement mentioned, *viz.*, 6 feet on the average, has been found sufficient for all practical purposes. Cleanings executed in this way have during the last few years been carried out over hundreds of acres. The Guard in charge of the work is given a few coolies to cut down the trees marked by him and the average cost of the operation is Re. 1 to Rs. 2 per acre. Fig. 6 (Plate 9) shows a cleaning carried out by a Forest Guard in the manner described.

VI.—THINNINGS.

Thinnings are made in crops over 6 inches diameter ; they are only marked by trained men, and considerable experience is required before the necessary degree of efficiency is obtained. The theory of thinnings is very simple, but in practice the marking of the same is by no means easy. A common fault is to remove only the suppressed trees and to be afraid to cut out dominating stems. Again and again I have seen this fault committed by people who should know better. It is essential that thinnings to do any good should be carried out in the top storey so as to give the dominating trees more room. Dominated trees, hindering the development of dominating trees, can also be removed, and if any sale exists for the produce suppressed, trees can come out, but the removal of these latter has no effect on the future crop. Mr. McIntire's opinion on this question extracted from a note, I have of his, is as follows :—

" Ever since I have been in the hills I have given every attention to the subject observing year by year, in some cases up to

four years, the results of thinnings I have myself made in known conditions, and trying to pick up what I could from the results of natural or accidental thinnings of longer standing. The result has been that I have come to the conclusion that in thinnings one should be guided entirely by the condition of the canopy formed by the dominating stems. That is to say, I believed a useful thinning would consist of the opening out of the canopy by the removal of a greater or smaller number of the dominating poles. The removal of the thoroughly suppressed poles occupying little or none of the space in the canopy appeared to me to be quite a minor consideration; the existence of such poles prove inattention and loss of increment in the past; but when they have become thoroughly suppressed they can exercise comparatively little influence on the leading stems. Their removal is probably desirable, but I think it has still to be proved that it is worth while to spend money on removing them if they are not marketable."

The next point to consider is the intensity of the thinning. Attempts have been made to define light and heavy thinning, but in reality these distinctions are better avoided. Opinions differ on the subject; it is hard to say that one is right and another wrong. The experienced sylviculturist should know exactly what degree of density he considers desirable in each and every case and should act accordingly. This is an art which can only be acquired by experience, continual observation and thought; nevertheless it can be acquired by any one of ordinary intelligence who applies himself seriously to this study. The Punjab Forest School has turned out some excellent men, who with practice and experience have become really expert in this work. Thinnings are better carried out gradually, say at intervals of 5 years rather that of 10 years, especially in view of the neglect of thinnings which has taken place in the past and of the consequent danger of snow-break, but in most hill forests a 10-year interval will probably be found most suitable. Care must be taken not to unduly interrupt the canopy or to leave vacant spaces. I may here mention the question of top-broken trees. Some people think these should invariably be removed which is, I think, a mistake; unless broken in half or otherwise irretrievably damaged,

such top-broken trees have a very great power of recovery. In many cases I have seen trees which had been top-broken twice and which had completely recovered and grown into sufficiently good trees. These top-broken trees should, therefore, only be removed under thinnings when they are interfering with the development of trees of the future and should not be cut out merely because they happen to be top-broken. If this latter is done, gaps are made in the canopy and open spaces left which are producing no increment. Mr. Troup has drawn attention to the damage done by the fungus *Peridermium Cedri*." This fungus appears to be much commoner and more injurious than was supposed. It is found over the whole of Kulu, and while as a rule only infesting individual trees or branches of trees, in some cases, such as Monali, it becomes a most serious pest destroying whole woods. In marking thinnings these facts should be remembered and infected stems removed as far as possible. The details of the sizes of the trees at different ages and the number to the acre present an interesting and attractive study which has not received sufficient attention in the past. Successful forest management does not consist in growing the maximum number of stems per acre, but in so arranging matters that the greatest mean annual increment of useful timber is obtained. Mr. McIntire continues :—

"At 40 years in average conditions the leading poles should be 9 inches to 12 inches in diameter and some 60 feet in height, with clean stems for at least half this height, and the total number of poles to the acre should be about 500, say 400 to 600. From the 40th to the 60th year thinnings should, I think, consist mainly of the weeding-out of the smaller poles, having their crowns in the canopy, but becoming flattened by their more vigorous neighbours. Such poles left to themselves become the thoroughly suppressed subjects one often finds at a later stage. Thinnings having been made, as I have suggested by the 60th year, we should only find well-grown poles and small trees 10 to 16 inches in diameter numbering between 200 and 300 to the acre. As the final crop cannot consist of more than 60 to 100 trees to the acre, the precise number depending on the length of he rotation and

the size of tree it is wished to grow, it is obvious that the greater part of these poles and smaller trees will have to be cut out in 20 to 40 years, for it is inconceivable that thinnings can be useful after the 100th year. In making such thinnings, our object should naturally be to cut out the smallest poles and trees so as to leave the best ones conveniently far from each other. It is after the crop has attained the condition I have noted it should present about the 60th year—in places it attains it by the 40th year, whilst in other places it does not attain it till the 70th year or even later—that the produce of thinnings becomes valuable for export. Ordinarily the number of poles and small trees to be removed in thinnings will not be less than 150 to the acre, nearly all being capable of yielding 1st class scantlings and of an average nett value of not less than Rs. 3 each. That is to say, assuming the rotation will not exceed 120 years, thinnings in the course of the rotation will produce not less than Rs. 450 per acre or Rs. 3 to 4 per acre a year throughout the rotation."

Mr. Troup, Sylviculturist, has supplied the following most interesting figures which are given in full at the end of this chapter:—

CEDRUS DEODARA.—*Allotment to quality classes according to height growth. (According to Mr. R. S. Troup, Sylviculturist.)*

Age.	HEIGHT IN FEET.		
	I quality.	II quality	III quality.
10	...	...	...
20	21 feet and over ...	Over 9 feet and under 21 feet	Under 9 feet.
30	36 ,, ,, ...	,, 17 ,, 36 ,,	,, 17 ,,
40	50 ,, ,, ...	,, 26 ,, 50 ,,	,, 26 ,,
50	65 ,, ,, ...	,, 36 ,, 65 ,,	,, 36 ,,
60	78 ,, ,, ...	,, 46 ,, 78 ,,	,, 46 ,,
70	90 ,, ,, ...	,, 55 ,, 90 ,,	,, 55 ,,
80	101 ,, ,, ...	,, 65 ,, 101 ,,	,, 65 ,,
90	111 ,, ,, ...	,, 74 ,, 111 ,,	,, 74 ,,
100	120 ,, ,, ...	,, 83 ,, 120 ,,	,, 83 ,,
110	126 ,, ,, ...	,, 89 ,, 126 ,,	,, 89 ,,
120	131 ,, ,, ...	,, 93 ,, 131 ,,	,, 93 ,,
130	134 ,, ,, ...	,, 96 ,, 134 ,,	,, 96 ,,
140	137 ,, ,, ...	,, 97½ ,, 137 ,,	,, 97½ ,,
150	138 ,, ,, ...	,, 98½ ,, 138 ,,	,, 98½ ,,
160	139 ,, ,, ...	,, 99 ,, 139 ,,	,, 99 ,,
170	139½ ,, ,, ...	,, 99½ ,, 139½ ,,	,, 99½ ,,
180	140 ,, ,, ...	,, 99½ ,, 140 ,,	,, 99½ ,,
190	140 ,, ,, ...	,, 100 ,, 140 ,,	,, 100 ,,
200	140 ,, ,, ...	,, 100 ,, 140 ,,	,, 100 ,,

CEDRUS DEODARA.—*Permanent Sample*

Division.	Plot No.	Age.	Mean height.	Mean girth.	VOLUME PER ACRE. Number of stems per acre.	Timber.*	Total† timber and small wood.	Mean sectional area per acre.
Chakrata (U. P.)	5	39	34	14·6	1,556	...	2,472	145
	6	39	39	12·7	1,772	...	2,315	124
	7	55	68	39·3	227	4,449	5,181	152
	8	45	61	34·0	517	6,049	7,929	260
	11	23	29	14·0	1,381	...	1,845	117
	12	23	31	16·1	921	...	1,556	103
	13	44	32	15·6	2,261	1,065	4,111	237
	14	44	38	19·6	749	882	2,407	125
	17	70	78	35·3	319	4,323	5,739	173
		61	53	25·1	700	2,667	6,392	191
		52	51	21·4	800	2,774	4,763	159
Bashahr (Punjab)	1	30	40	22·6	665	880	2,711	148
	2	30	38	15·9	1,576	455	3,377	172
	3	52	59	33·3	294	2,667	3,512	142
	4	52	53	24·5	754	2,987	4,949	196
	5	51	78	41·6	268	6,064	6,828	202
	6	31	27	11·1	1,660	...	1,111	90
	7	77	60	29·5	318	2,735	3,514	120
	8	77	52	23·0	805	3,689	5,282	185
	9	216	76	51·1	170	5,786	6,200	185
	10	254	98	88·8	136	13,567	13,837	466
	18	110	86	47·5	124	3,922	4,227	121
Kulu (Punjab)...	1	48	80	40·3	202	1,399	2,052	142
	2	48	85	38·5	216	945	1,355	139
	3	27	53	23·8	511	960	2,862	126
		37	64	33·0	344	2,652	3,895	163
	4	The statistics are of no value for the present ; age uncertain.						
	5	80	92	43·0	135	5,559	5,923	109
	6	59	60	26·7	283	1,755	2,760	87
	7	40	48	20·3	521	1,189	2,478	94
	9	86	78	34·4	243	4,363	5,348	125

NOTE.—* *Timber* includes everything in the pole down to a

† *Smallwood* includes everything from 24 inches

Plots laid out by Sylviculturist.

Elevation.	Aspect	Rock.	Soil.	Thinned or unthinned.	Quality.	REMARKS.
Feet.						
7,800	N. E.	...	Deep moist ..	T.	II	Plantation.
7,800	N. E.	...	Ditto ...	Un.	II	Ditto.
7,800	N.	...	Good ...	T.	II	Natural crop.
7,800	N.	...	Ditto ...	Un.	I	Ditto
8,000	W. N. W.	Limestone and slaty conglomerates.	Good deep loam.	Un.	I	Plantation.
8,000	W. N. W.	Ditto	Ditto ...	T.	I	Ditto.
8,500	W.	Shale with bands of limestone.	Ditto ...	Un.	II	Natural crop.
8 500	W.	Ditto	Ditto ...	T.	II	Ditto.
} 8,500	W. N. W.	Shale ...	Ditto ...	T.	II	Ditto.
7,000	E. S. E.	Micaceous schist, sandy.	Good deep humus.	T.	I	Natural crop.
7,000	E. S. E.	Ditto	Ditto ...	Un.	I	Ditto.
7,500	N. E.	Granite ...	Good deep fertile.	T.	II	Ditto.
7,500	N. E.	Ditto ...	Ditto ...	Un.	II	Ditto.
7,000	W. N. W.	Ditto ...	Ditto ..	T.	I	Ditto.
7,000	W. N. W.	Ditto ...	Sandy ...	Un.	II	Ditto.
8,500	N. N. E.	...	Sandy loam	T.	III	Ditto.
8,500	N. S. E.	...	Ditto ...	Un.	III	Ditto.
8,500	N. W.	Gneiss ..	Ditto ...	Un.	III	Ditto.
8,800	E. N. E.	...	Ditto ...	Un.	III	Ditto.
7,000	S. W.	Mica schist ...	Deep fertile loam.	T.	III	Ditto.
6,000	...	Mica schist and gneiss.	Deep fertile sandy loam.	T.	I	Plantation.
6,000	...	Ditto ...	Fertile micaceous loam.	T.	I	Ditto.
} 6,000	...	Ditto ...	Ditto ...	T.	I	Ditto.
5,500	N. W.	Mica schist ...	Micaceous sandy loam.	T.	II	Natural crop.
6,000	N. W.	Ditto ...	Sandy ...	T.	II	Ditto.
6,000	W. N. W.	Ditto ...	Micaceous sandy good fertile.	T.	II	Ditto.
6,000	W.	Ditto ...	Ditto ...	T.	II	Ditto.

girth (over bark) of 24 inches : timber *excludes* bark.
down to 6 inches girth : smallwood *includes* bark.

VII.—The Final Crop.

It is not possible at this stage of our knowledge to give precise details of the final crop which will be obtained under a regular system of management such as I have indicated. The final crop will consist of a fully stocked wood of well-grown trees approximating to the size it is desired to grow and yielding a very large volume of first quality timber to the acre. The number of trees to the acre will vary with the length of rotation and the size of the tree it is desired to grow ; the rotation will be based on the value of the different sizes of tree, on the mean annual increment of single trees and of crops. As regards figures for the ages and outturn of single trees, a mass of statistics is already available both for Chamba and Kulu, and it is essential that such information should continue to be collected. Regarding figures for the yield of crops, the Forest Research Institute have this matter in hand and will soon be in a position to publish figures on the subject. With these figures to guide us it will be possible to adopt the rotation, giving the maximum financial return and to grow that size of tree which is most profitable. Assuming the final crop of deodar trees 30 inches in diameter to number 50 trees per acre, value Rs. 40 each, and taking the rotation as 120 years divided into four periods of 30 years each, the return on 40,000 acres of deodar forest will work out at over 6½ lakhs a year. There is no reason why eventually Kulu should not produce this revenue. All that is necessary is a proper scientific system of forestry, and the expenditure of considerable sums of money on works of reproduction and improvement.

MOTION PICTURES TO STOP FIRES.

An interesting departure has been made in British Columbia to make our people realise the great importance of the lumber industry and the necessity of protecting the forest resources of British Columbia from damage by fire.

Moving pictures have nowadays an educational power only second to that of the Press itself. Hence last year a number of the motion-picture theatres in the Coast province were supplied

with a set of slides to be used in the intervals between the ordinary films, the pictures bearing the following legends, each supported by a typical forest scene:

"One moment please! While waiting, resolve to be careful with fire in the woods."

"Only six trees (shown in picture) but their manufacture into lumber employed 100 men for one day. Put your fire out."

"$400,000 reward! is what the lumber industry of the Pacific North-West pays the community *daily* for labour, supplies, etc. *You* share it. Be careful with fire in the woods. The road to prosperity lies through the forests; don't burn them up!"

The slides were sent out under instructions from the Minister of Lands with a letter explaining the need for the co-operation of the theatre proprietors in order to reach a large body of the public inaccessible by any other means. The result was entirely satisfactory, both theatres and patrons expressing their appreciation.

This year the idea was extended, every motion-picture theatre in British Columbia receiving a set, the subjects being more direct in their appeals, as is shown by the inscriptions:

(1) "*Wage earners and Merchants!* The lumber industry already employs over half the wage earners in British Columbia, and distributes over 20 million dollars annually for labour and supplies. . . . Make it permanent by protecting the Forests from fire." (View shown of export sawmill with shipping.)

(2) "*Taxpayers!* Forests pay into British Columbia Treasury 2½ million dollars annually. . . . Prevent fires, and keep your taxes down." (Logging scene.)

(3) "*Hunters and Fishermen!* Green forests afford shelter for game, and clear water for fish. . . . Help keep them green."—(Forest Guard in canoe on patrol.)

Forest Reservations in United States.

The lands approved for acquisition by the United States Government for national forest purposes in the east, since the purchase policy was inaugurated in 1910, now total 1,104,000 acres, representing a purchase price of $5,500,000. About $2,000,000 of

the original appropriation remains available for further purchases in the fiscal year 1915. The lands favourably acted on to date include 133,000 acres in the White mountains of New Hampshire, while 971,000 acres are located in various parts of the southern Appalachians, from Virginia to Georgia. Nearly 400,000 acres were approved for purchase during the past year, at an average price of $4·96 per acre.

The first object of administration is to protect the forest against fire, for the twofold purpose of steadying stream-flow and increasing timber production. There is, however, provision for all forms of use of the forests not detrimental to their permanent value as sources of timber and water-supplies.—[*Canadian Forestry Journal.*]

THE SEED OF VATERIA INDICA TREE.

A *Supplement to the London Chamber of Commerce Journal* for July dealing with the "Trade Products of the British Empire" says:—The war in Europe has been preventing exports from India of the seed of the *Vateria indica* tree, known also as the *piney tallow tree*, and producing a substance known as vegetable tallow, which formerly found its cheif market in Antwerp. This tallow is said to be useful in the manufacture of candles and of soaps and to bring almost the same price as good animal tallow. It is said that after refining it is edible and suitable for use in making confectionery. It is only of late years that attempts have been made to exploit these seeds and their tallow commercially. The results, however, have been so eminently satisfactory and the prices obtained in Europe for both the seeds and the tallow so favourable that it became evident that the raw product was of exceptional value. This fact has been confirmed by actual sales of tallow after refining at over £100 per ton in Europe. The seed is collected in the form of a husked kernel, which, after removal of the husk, is artificially dried, this process generally resulting in the splitting up of the kernel into three or four pieces. In this form it is ready for export. The kernels after drying and treat-

ment by a solvent process yield an average of 30 per cent. of their weight of a solid tallow, the constitution of which can be referred to in any standard work on oil-seeds. This tallow after refining is edible in the highest degree and, from the prices obtained for it, it must also possess some very special properties. It is said to be largely used in the higher branches of confectionery. The price of the dried kernels f.o.b. Bombay packed in gunny bags would be somewhere about £9 10*s.* per ton gross.—[*The Indian Trade Journal.*]

PRESERVATION OF TIMBER BY THE ANCIENTS.

It is generally believed that the ancient Egyptians were acquainted with some method of preserving wood, as wooden coffins, believed to be at least 2,000 years old, have been discovered in a good state of preservation. These were made of solid blocks of sycamore wood, scooped out, and as sycamore is a wood that does not endure for any great length of time without some preservative treatment, it is but natural to conclude that it was so subjected, especially as the wood had the appearance of being impregnated with some bituminous substance.

It is also asserted that the ancient temples of Egypt contain the oldest wood in the world in the shape of dowel pins, which are incorporated with stonework, known to be not less than 4,000 years old. These dowel pins are supposed to be made from the tamarisk, or shittim wood, in ancient times a sacred tree in Egypt.—[*Timber Trades Journal.*]

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Photo. by R. S. Troup.

Tramway running through Sal high-level forest, Goalpara Division, Assam.

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CONVERSION OF GOALPARA FOREST TRAMWAY TO STEAM TRACTION.

BY A. R. DICKS, I.F.S.

In the *Indian Forester* of September and October 1906 an account of this tramway was given. Up to 1912-13 hand traction was used for conveying the trucks loaded with timber, but in 1911-12 it had already become evident that we could not get enough labour to cope with a longer lead, necessitated by the extension of the tram-line to more remote parts of the reserve, and a greatly increased outturn due to more extensive departmental sleeper operations and the influx of Bengali timber traders from the Buxa Division which had begun to take place. It was clear that some mechanical means of transport must be introduced, as the use of draught animals was ruled out in the cold weather owing to want of water, the forests being in the 'bhabar' or waterless belt at the foot of the Himalayas. As an unlimited supply of firewood was at hand, it seemed that a light locomotive adapted for burning wood fuel would be the most economical. The cost of running such a locomotive was worked out and it was calculated that the cost of transporting a metre-gauge sleeper from the forest to terminus of

tramway on river, by rail, would be about one-fifth of the cost by hand traction. (This was afterwards found to be an underestimate. The actual cost of railing a metre-gauge sleeper was 1·2 anna as compared with 4 annas.) The next step was to find out what alterations would be required to the existing track to make it passable for a locomotive and the cost. The total length of permanent track was 15 miles and there were 4 miles of temporary track. The rails were 14 lbs. per yard in lengths of 16½ and 19⅝ ft. About 9 miles of the permanent track was laid on Sal sleepers 4′ × 5″ × 4″ and 4 miles on iron trough sleepers 2′-8″ × 5″ and 2 miles on Sal slabs, these being the wastage from the conversion of metre-gauge sleepers, of varying widths and thicknesses. The spacing of the sleepers varied from 2′ 8″ to 3′ 6″ and in some cases 3′ 9″ centre to centre, and the curves were mostly of 40′ radius. The streams were bridged by hand-driven pile bridges. As regards the character of the soil on which the track was laid, 3 miles of it are on paddy field clay and exposed to inundation in the rains and another 2½ miles on similar clay soil but somewhat higher and not subject to inundation. These 5½ miles traverse savannah land or cultivation. The remainder of the permanent track, 9½ miles, traverses high level Sal forest and the soil is well-drained loam with no streams to bridge. The steepest gradient against the load was 1 in 170. The average gradient was 1 in 500, and in the forest section there was an almost uniform rising grade from south to north After leaving the forest there was a slight upward grade for about 2 miles and then a slight downward grade all the way to the terminus on the Gorufela river. At the request of the Conservator the E. B. S. Ry. kindly sent two officers to inspect the track in November 1912. Their recommendations were to get an engine with four coupled wheels weighing 4·5 tons in working order, capable of hauling a gross load of 30 tons up 1 in 100 grade at 5 m. p. h. or a paying load of 20 tons. To make the track suitable for this locomotive the sleepers were to be re-spaced to an uniform distance of 2 ft. centre to centre, the bridges were to be strengthened and the curves eased off to a radius of 150 ft. Correspondence ensued with the makers of light locomotives, and it

was then found that a locomotive of the above weight would not haul the loads mentioned above. As this is a point of considerable practical importance to intending locomotive users, I give the details of the calculations. The question was whether a locomotive catalogued at about 12 h. p. with a cylinder diameter of 5″ length of stroke = 8″, diameter of wheels 20″, weight in working order 4·5 tons and with a normal working pressure in boiler of 176 lbs. per square inch could haul, as catalogued, a weight of 38 tons of 2,000 lbs. up a grade of 1 in 100.

The tractive force of a locomotive is calculated by the formula

$$T = \frac{D^2 P L}{W}$$

Where P = mean pressure of steam in cylinder in lbs. per square inch.

D = diameter of cylinder in inches.

L = length of stroke in inches.

W = diameter of driving wheel in inches.

If we substitute in this formula the values given above we get

$$T = \frac{5 \times 5 \times 176 \times 8}{20}$$

$$= 1{,}760 \text{ lbs.}$$

This is assuming that the full boiler pressure of 176 lbs per square inch is exerted in the cylinder, but in practice this is not the case. The English and American practice is to calculate the cylinder pressure at 65 per cent. to 75 per cent. of the boiler pressure, and in the case under consideration the tractive force was catalogued at 1,350 lbs. which is slightly over 75 per cent. of the above boiler pressure, but on the Continent they calculate 50 per cent. to 60 per cent. at most, and one well-known Continental firm informed me that, in this very small type of locomotive, 50 per cent. cylinder pressure was the maximum that could safely be figured. If we accept this as correct, the tractive force would be reduced to 880 lbs.

The load which an engine will take on a given incline

$$L = \frac{T}{G + R} - W$$

Where G = resistance due to gravity on the steepest gradients in lbs. per ton.

R = resistance due to assumed velocity of train in lbs. per ton.

T = tractive power of engine in pounds.

W = weight of engine and tender in tons.

L = load the engine can take in tons including weight of waggons but not that of engine and tender.

The values of G and R are taken from tables, but on narrow gauge lines the tractive force required to haul one ton on the level is generally taken as 20 lbs. which is just double that on a broad gauge line which is taken as 10 lbs. The values of G and R must, therefore, be doubled in the above formula.

R is not given for velocities of less than 10 miles per hour in Molesworth, whereas the velocity of these small locomotives is 5 miles per hour, but from the formula

$$R = 6 + \cdot 009\ V^2$$

the value of R becomes 6·2 when V is 5.

The values of G and R would then be as follows :—

Gradient.	Double value of G + R in lbs. per ton.
Level	20
1 in 500	21·4
1 in 400	23·6
1 in 300	27·4
1 in 200	34·8
1 in 100	57·2

with an available tractive force of 880 lbs. we should arrive at the following figures. Haulage inclusive of weight of engine about

44 tons on level.
41 tons on 1 in 500.
32 tons on 1 in 300.
25 tons on 1 in 200.
15 tons on 1 in 100.

Practical tests have, however, so the firm stated, shown that even these figures cannot be taken as correct, and while the hauling capacity of the engine on the level would be somewhat more than that shown above, the figures show a considerable

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Photo. by R. S. Troup.

Forest tramway, Goalpara Division, Assam.
The Engine.

reduction on gradients of 1 in 200 and 1 in 100, because curves, slippery rails and track not accurately laid down have a retarding influence on the tractive force in the steeper gradients. It is clear, then, that would-be purchasers of locomotives would do well not to accept *in toto* the figures of the manufacturers, but work out the figures for themselves from the formulæ.

As it appeared that the four-coupled engine recommended to be purchased was not capable of doing the work required, it was decided to get a more powerful engine, and as this of course meant a heavier engine it became necessary to increase the number of wheels in order that the pressure on our 14 lbs. rails might not be too much. The locomotive eventually decided on was a 20 h. p. one with six-coupled wheels weighing in working order 6 tons 14 cwt. The pressure per weel on the rails was thus 1 ton $2\frac{1}{3}$ cwt. = 2,502 lbs. against a maximum permissible with sleepers 2 ft. apart from centre to centre of 2,688 lbs. The next point was to decide to which makers to go to for the purchase of the locomotive. It was found that English built engines were built for coal fuel, and that though they could be built to order for wood fuel it would take much longer as the design would have to be altered. Moreover, as light locomotives at home are never run on wood fuel, whereas on the Continent they frequently are, it seemed sounder to go to a firm who had plenty of experience in building lengines of this type. It was eventually decided to obtain the locomotives from Messrs. Orenstein and Arthur Koppel. (*N.B.*—This was 9 months before the modern Huns launched their bolt from the blue on an astonished Europe by their declaration of war, and at a time when a war between Germany and England seemed unthinkable. To give the devil his due the locomotive supplied has been quite a success, but it will always remain a grief to the writer that we did not go to a French firm, for instance, the Decauville Co., instead of a German one.) The engine supplied had six-coupled wheels, diameter of cylinder $5\frac{7}{8}''$, length of stroke 10", diameter of wheels 22". The tractive force calculated as above at 50 per cent. cylinder pressure comes to 1,322 lbs. and we arrive at the following figures showing the load which this

engine should take. Haulage inclusive of weight of engine about 66 tons on level.

61 tons 1 in 500.
48 tons 1 in 300.
38 tons 1 in 200.
23 tons 1 in 100.

While the locomotive was being brought out from Europe the necessary alterations to the track were taken in hand.

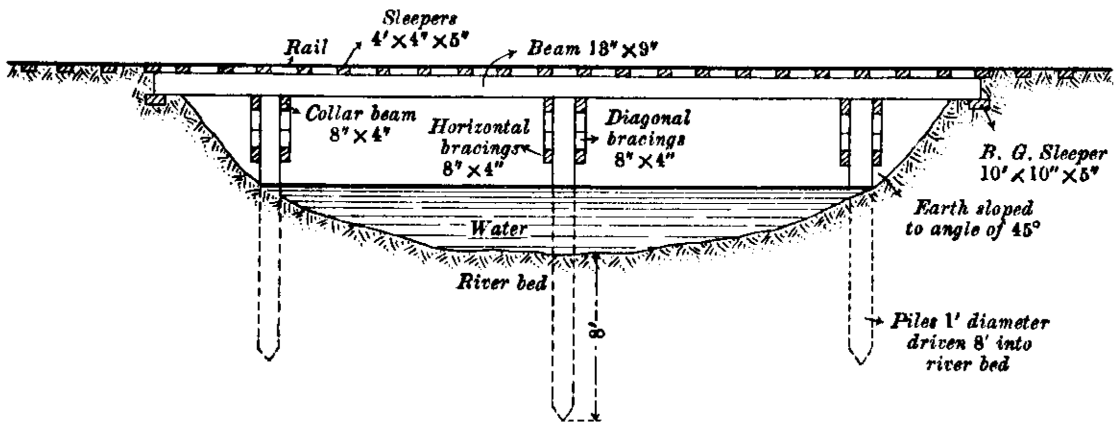
These included the lifting of 16 m. 29 ch. of line and re-spacing the sleepers to 2 ft. from centre to centre. Incidentally on certain sections of the main line totalling 4 m. which had been laid on iron sleepers, the sleepers were replaced by wooden ones which are much more satisfactory and the iron sleepers were collected for use on temporary extensions. 1 m. 48 ch. of line were regraded to a slope of 1 in 200. Eleven bridges aggregating 352 r. ft. were reconstructed. An engine shed and quarters for the loco. staff were erected. A good stock of wooden sleepers, about 13,000, were cut for extensions and renewals. All the curves were eased off to 150 ft. radius. All this work had to be done by outside coolies, 400 of whom were imported, as no spare local labour was obtainable.

The construction of the bridges involved little difficulty. The soil being clay or loam to a great depth, ordinary wooden pile bridges were adopted. The piles were dressed Sal posts one foot diameter at the top, and they were driven to an average depth of 8′ to 9′ by means of a pile driver consisting of an iron monkey weighing ¾ ton elevated by an ordinary crab winch and chain. To secure a firm abutment the end bridge beams were made 1′ 6″ longer than the length of the end piles of the bridge above the ground, and the ends of the bridge beams rested on a broad gauge sleeper 10′ × 10″ × 5″ laid horizontally across the track and embedded in the earth. One foot from this sleeper the ground was sloped to the angle of rest about 45°. A plan of the type of bridge adopted is attached—(Plate 9C).

Arrangements for watering the engine had to be made in two places, one at Kochugaon, and one at the Gangia river, about 3

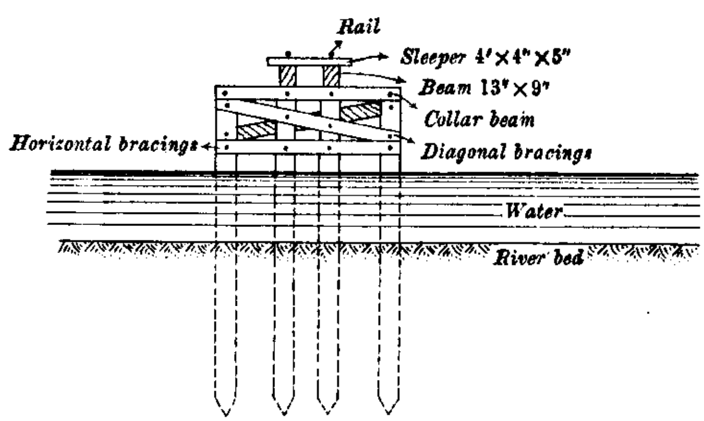
A SKETCH OF A BRIDGE.

Type of bridge built for Locomotive traction
Kochugaon Forest Tramway.



SIDE VIEW.

Scale—10 Feet = 1 Inch.



CROSS SECTION.

At Gangia Bridge.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee. Photos by G. N. Simson.

At Camp.

miles north of Kochugaon, the last place where permanent water is found till quite near the foot of the hills, a stretch of about 10 miles. At Kochugaon a Raniganj pipe well 2 ft. diameter was dug close to the railway line. The water-level at the driest time of the year was found to be 12 ft. from the surface. An elevated platform 12 ft. high was constructed by arranging rejected metre-gauge sleepers crossways over each other on which an iron tank of 400 gallon capacity was placed. By means of an ordinary suction rotary hand pump installed alongside the tank, water was raised from the well. This arrangement was found to give an ample supply of water for locomotive purposes. At the Gangia river an elevated platform 8 ft. high was built over the bridge and a pump similar to that at Kochugaon was installed, the water being led directly from the river into the tank. The tank of the engine has a capacity of 100 gallons. Here it is to be remarked that for this tramway a tank of much larger capacity would be a desideratum, as it is found necessary to refill the tank every 5 miles on the up trip. This is done, as no water is obtainable beyond Gangia, by means of an extra tank with a capacity of 380 gallons carried behind the engine and carried on a truck on an elevated platform and fitted with a stop cock, so that the water runs down a connecting length of hose-pipe into the boiler tank when the cock is turned. It takes about 20 minutes to refill the engine tank and so the waste of time is considerable, as the engine has to be stopped while the tank is being refilled. On the down trip so much steam is not consumed, as steam is shut off for a large part of the run, it being mostly a down gradient, and the tank has only to be replenished once.

As regards fuel, outside slabs of Sal logs from the conversion of sleepers have been used. These were carted from the forest to the rails and then railed to Kochugaon, hand-sawn into lengths of 12" to 16", and the larger pieces split if necessary. The cost per hundred stacked cubic feet comes to Rs. 5 and the engine consumes about 1,000 stacked cubic feet per month. To keep the fuel from becoming wet it has been found necessary to erect a fuel shed of corrugated iron 60 × 40.

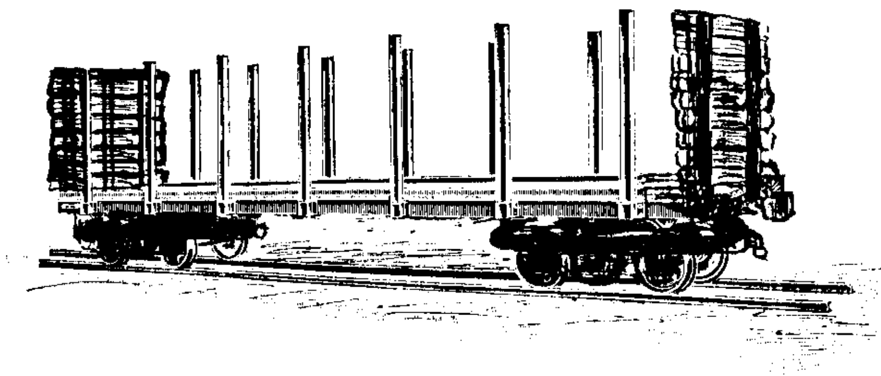
Now as to *trucks*.—The old type of iron truck carried $1\frac{1}{2}$ tons. These have done good service and many are still in use, but for locomotive power they have disadvantages. They are very light and therefore liable to jump the rails when being taken empty, the tread of the wheels is narrow $2\frac{1}{4}$ inches, which renders them more liable to derailment, and they have not got spring buffers. A new type of truck was called for. It is much heavier and stronger than the old and carries 2 tons, has wheels with 3 inches tread and is provided with spring buffers and a better type of coupling. These trucks have been found in every respect suitable for our work and have been adopted as our standard type. An illustration of one of these is given.—(Plate 9E). For transport of sleepers two of them are joined together by a wooden framework laid over the bolsters as shown in the illustration. The framework consists of two longitudinal Sal scantlings 14 ft. long $6'' \times 4''$ connected by transverse pieces, and at the ends are two wooden uprights with planks nailed across. The metre-gauge sleepers are placed longitudinally in the one long truck thus formed, and to keep them from falling out sideways, iron sockets are fitted on to the longitudinal scantlings that make the framework, into which 6 ft. lengths of rails are fitted. These trucks hold 64 metre-gauge sleepers weighing 3 tons. For transport of logs two trucks are used without any framework, the ends of the logs being laid directly on the bolsters.

All our trucks have outside journals with fixed gun-metal bearings. We tried the roller bearings so extensively advertised by some firms and found them to be useless. In a comparatively short time with these roller bearings the axles get worn away at the end to a spindle shape. I was informed by the Engineer of the E. B. S. Ry. who inspected the tramway that they had found the same thing happen on their railway and that they had scrappled all of the axles with roller bearings. We also tried the white metal (anti-friction metal) bearings, but found that these need renewing fairly often, whereas the brass or gun-metal bearings last for a long time.

Loading arrangements.—Posts and light logs are loaded by placing two posts against the framework of the trucks, previously

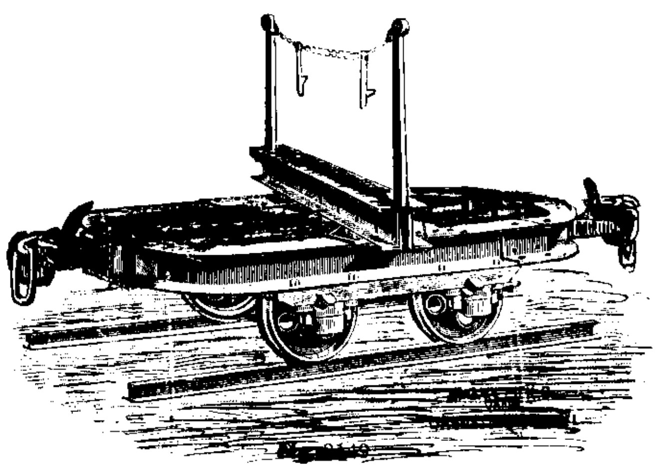
NEW TRUCKS WITH SPRING BUFFERS AND STRONG COUPLINGS.

Fig. 1.



Total length of sleeper frame 14′ width 3′.

Fig. 2.



Total length of sleeper frame 14′ width 3′.

wedged firm by placing two pieces of wood at each end across the rails underneath the framework, and rolling the posts and logs up these by two men. Heavier logs are loaded by means of two portable uprights on stands with cross pieces on top connecting them, from which is suspended a pulley block, as elephants were not available. The log is rolled in between the rails, a chain tied round at each end, the tripods are erected one on each side, one end of the log is lifted by means of the pulley block, a truck rolled underneath. Then the other end lifted and the other truck put in position.

Brakes.—Some of the trucks are fitted with powerful screw brakes and two of these are taken with each train. The train attains a considerable speed on the down gradients and extra braking power in addition to that of the engine was soon found a very necessary precaution.

The packages comprising the locomotive arrived at Sapatgram, the nearest railway station 19 miles from Kochugaon, in March, which was much later than had been anticipated. The weight of the largest package being over 3 tons it was not possible to cart it over the kutcha bridges affected by the P. W. D. in these parts, and the only way was to boat it up the river in which at that, the worst time of the year, there was in places less than 1′ 6″ of water. However, the local boatmen asserting that they could take it up if there were only 1 foot of water, it was resolved to make the attempt, and most fortunately two or three days before this was done there was some rain which added several inches to the depth of water. Two "mars" were formed by erecting a platform of planks over two dugouts, the packages were loaded on to these and then taken up the river partly by poling and partly by towing or both where the current was rapid. The "mars" arrived at Gorufela all safely much to the relief of every one concerned, and the locomotive was duly assembled. Here it may be mentioned that we have only once had serious trouble with the engine. This was when the rear transverse spring between the two back wheels broke, due no doubt to the unevenness of the track, and we had to send down to Calcutta for another which resulted in the locomotive being idle for three weeks. Barring this there have been very few days indeed when it has

not been working, and these have been mostly due to the illness of the driver. Our principal difficulty in running the locomotive in the rains was the slipperiness of the rails which caused the wheels to revolve without progressing, and this was aggravated by the sand in the sand boxes absorbing moisture from the air and getting clogged in the pipes. We found it impossible to haul a full load for these reasons.

Even with the sleepers only 2 ft. apart, the 14 lb. rails are found to bend excessively under the weight of the engine. It is especially at the joints of the rails that this bending occurs, and we found it necessary to put one sleeper on each side of the joint just touching the ends of the fish-plates, so that the sleepers at the joints are only 1 foot apart. Where the ground is soft it was found necessary to space the sleepers only 18 inches apart instead of 2 ft. In reality these 14 lb. rails are not suitable for even the lightest engine whatever the makers may say. We intend gradually to replace the 14 lb. rails by 18 or 20 lb. rails. The moral is, when you lay down a light railway don't use anything lighter than 18 lb. rails. The difference in price and in portability is small, and you may want to introduce locomotive traction afterwards. There was one place at the end of a temporary extension where the locomotive had to perform a somewhat difficult piece of work. A large number of sleepers had been stacked at the foot of a steep declivity some 30 ft. high. Labour and time available would only permit of the slope being reduced to 1 in 23 by means of a cutting and a hastily thrown up embankment. The locomotive had to haul the loaded trucks up this slope. She did it all right, but she could only haul one fully loaded sleeper truck = 3 tons at a time.

The average number of trucks hauled was eight double trucks containing 24 tons of sleepers and one brake-van and one extra tank for engine, and two extra tanks of water for use of the coolies engaged on road and timber work. The side bunkers on the engine have a capacity of 18 c. ft. and do not hold enough fuel for one day's consumption, some extra fuel is therefore carried on the brake-van.

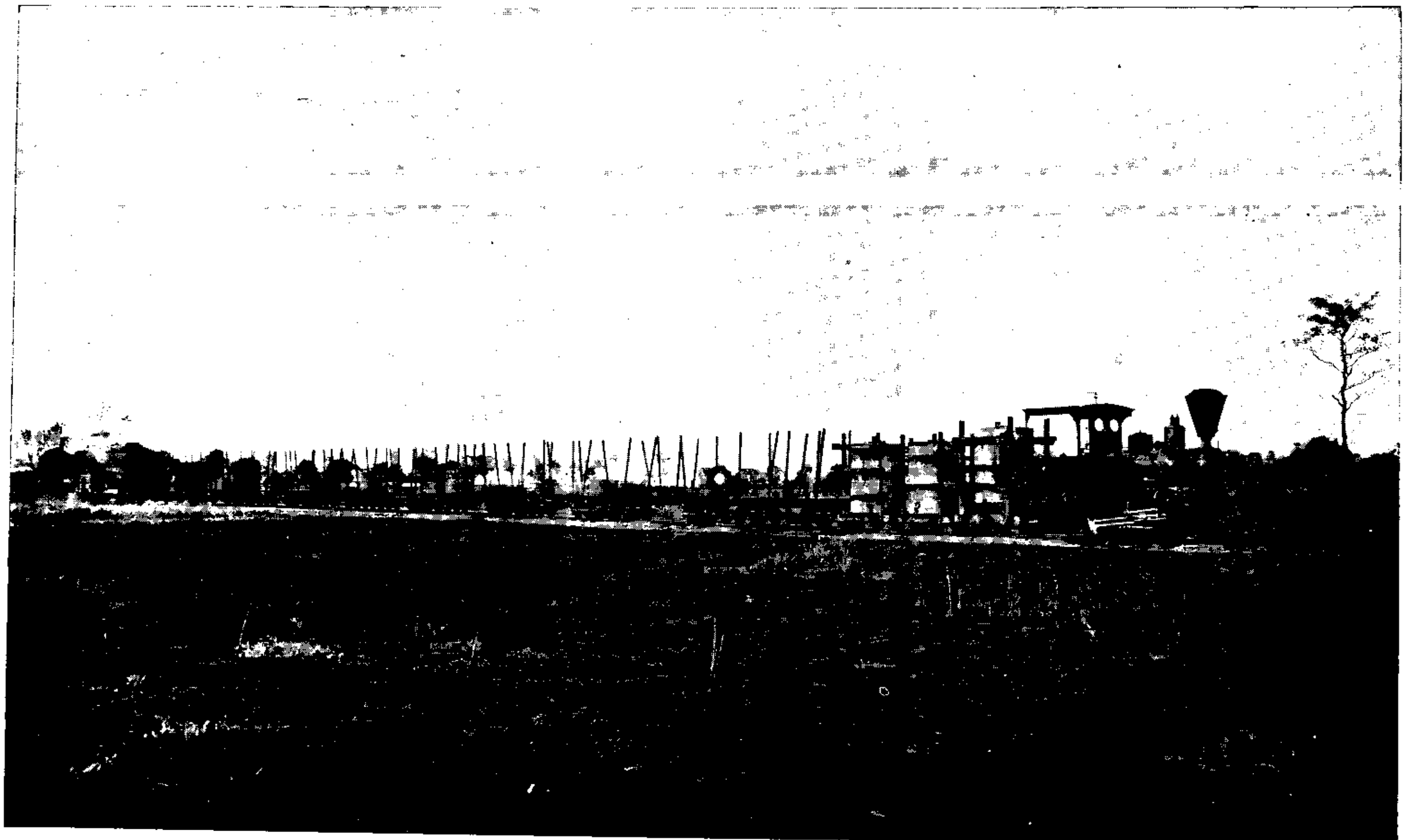


Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Photo. by R. S. Troup.

Forest tramway, Goalpara Division, Assam.
An empty sleeper train ready to start for the forest.

The weight of the train unloaded is a little over 14 tons made up as follows :—

16 Freight trucks at 700 lbs. each	=	5 tons.
1 Brake truck with spare fuel	=	1 ton.
3 Water tank trucks	=	$1\frac{1}{2}$ tons.
1 Engine	=	$6\frac{7}{10}$ tons.
		$14\frac{1}{8}$ tons.

The distance the sleepers were railed from forest to terminus on the Gorufela river, whence they are boated down to the Eastern Bengal State Railway, was about 18 miles of which 15 miles was permanent track on wooden sleepers and 3 miles temporary tracks. Iron sleepers were used as much as possible on the temporary track, and they were obtained from those lifted from the permanent track and replaced by wooden sleepers. As the speed of the train was limited to 5 miles per hour when hauling empty trucks, and 6 miles per hour when loaded, it was only possible to make one return trip to the forest and back per day. The train could proceed at a much higher speed than this, but when this was permitted it was found that derailments were too frequent.

Now as to *the results of the working of the locomotive.*—The expenditure incurred up to June 1915 was Rs. 51,555. The timber, etc., transported from 1st July 1914 up to 30th June 1915 is as follows :—

	Sal.	Earnings. Rs.
M. G. sleepers	49,659	12,414
B. G. sleepers	124	62
M. G. sida	214	53
Planks and scantlings ...	669 c.ft.	91
Logs	11,432	1,429
Posts	17,250	2,156
		16,205
Water for coolies engaged on forest work ...		1,000
Total ...		17,205

In this statement the earnings on carriage of sleepers and planks and water are calculated at the rates we should have had to pay for their transport by coolies if the locomotive had not been bought. The earnings on logs and posts are the money actually paid by purchasers for freight.

Though the locomotive was working from July 1914 it was not till November 1914 that it started full working.

The working expenses during the same period were as follows:—

	Rs.
Oil (lubricating and lighting and cleaning) ...	1,043
Other stores (including spare parts for loco.)...	487
Establishment	1,387
Fuel	397
Permanent-way gangs	3,544
Loading and unloading sleepers ...	438
Total ...	7,296

The net profit on 12 months' working was thus Rs. 9,909. Better results could have been shown had we had more trucks as the locomotive was not hauling full loads the whole time owing to want of trucks. Unfortunately the outbreak of the war put a stop to our securing more trucks of the right pattern, and we have not been able to get satisfactory trucks made in Calcutta.

The monthly working expenses are made up of the following items:—

Cost of running (*viz.*, fuel, lubricating oil, wages of loco. staff) = Rs. 289 per month as follows:—

	Rs.
Fuel 1,000 st. c. ft. at Rs. 5 per cent. ...	50
Oil $2\frac{1}{2}$ maunds—	
$1\frac{1}{4}$ mds. axle oil for trucks at Rs. 14	
$1\frac{1}{4}$ mds. castor oil for engine at Rs. 20 ...	42
Miscellaneous (cotton waste, jute, kerosene oil, black lead, etc.)	15
Total ...	107

Wages of staff—

					Rs.
Driver	...	...	...	...	90
Fireman	...	...	...	...	20
Do.	...	...	...	...	15
Lighter and cleaner		...	...	...	15
Cleaner of trucks		...	...	...	15
Guard (moharrir)		...	...	...	15
Brakesman		...	...	...	12
					182
			Total	...	289

Cost of Permanent-way staff—

One permanent-way mistri at Rs. 45 Two gang mistris at Rs. 20 22 gang coolies at Rs. 15	415
Grand Total ...	704

It seems to me that these figures are open to criticism, and I invite such from any of our friends on the railways. The consumption of lubricating oil seems to be excessive, yet I am assured by the Range Officer that it is all used properly. The axle oil, which is a black mineral oil, is useless to the natives, so is not likely to be stolen. The only reference I can find to the subject is in Molesworth who gives the consumption figures in America as one pint of oil to eight journals for a distance of 250 miles. Reckoned on this basis and taking our average train to have 84 journals, our consumption should be for 26 working days not more than $\frac{5}{8}$ maund instead of $1\frac{1}{4}$ maunds. I presume that a badly laid track would necessitate an increased consumption of oil and also that the climate may have some effect in the same direction.

As regards the staff employed, the wages of the driver may appear excessive, but we found we could not get a good man to stay at a place like Kochugaon, where he is cut off entirely from his kind, for less. Our driver must have sufficient knowledge to

do petty repairs and replace worn parts as we are not within reach of any railway workshops or Loco. Inspectors. His pay is only Rs. 60, but then he gets a rupee a day trip allowance for each day the engine does a full trip, and Re. 1 for working on Sunday, when he superintends the cleaning of it and overhauls it generally—the object of course being to give him an interest in keeping his engine at work.

The permanent-way staff seems costly too. But they have between 18 to 19 miles of unballasted line to attend to. At first we had fewer men and we found derailments too frequent. Will some other users of light locomotives give the results of their experience?

The larger photos. that accompany this article were taken by Mr. R. S. Troup, D. C. Forests, and the smaller by Mr. G. N. Simeon, A. C. Forests. I am much indebted to both these officers for permission to use the photos.

FOREST INSECT INVESTIGATIONS IN AMERICA.

The Annual Report of the Chief of the Bureau of Entomology, United States Department of Agriculture, for the year 1914, includes some important results obtained by Dr. A. D. Hopkins, Entomologist in charge of Forest Insect Investigations :—

" *Demonstration of control methods against the Dendroctonus bark-beetles.*—The fiscal year just closed marked the culmination of the work which has been done towards the control of the very dangerous bark-beetles of the genus *Dendroctonus*, so injurious to conifers in various parts of the country. The final examination of the principal control areas from two to eight years after the control work was done has completely established the practicability of the bureau's methods.

The first cost should rarely, if ever, exceed the stumpage value of the infested timber. If treated timber cannot be utilised and must be left to decay, the value of the timber protected by the operations, and which would otherwise have died within the next year or two, will more than balance the first cost ; so that

continued protection will represent cumulative profit. Work of this character has been carried on by the Forest Service along the lines laid down by the Bureau of Entomology, upon forest reservations, with most gratifying success, while other work carried on by private owners and by rail-roads and on the Indian reservations under directions from the bureau has been equally successful.

In all of this work the percentage principle of insect control has been applied. This means that in order to protect a forest by no means all of the infested trees must be felled or barked. To treat 75 per cent. of those infested will be ample, and in some cases this percentage may be greatly reduced. From 25 to 75 per cent. of the infested trees must be disposed of, leaving the remainder of the infested trees to be cleaned of bark-beetles by parasitic and predacious insects, birds, diseases, and so on. This is really an extraordinary discovery and greatly simplifies control work and also greatly lessens its cost."

The statements quoted above are, in all probability, equally applicable to the bark-beetles and associated insect fauna of the Himalayan coniferous forests, where outbreaks of a similar nature occasionally occur, but fortunately on a much less extensive scale. With regard to the interrelation of insects and forest fires, the report adds that—"*Dendroctonus* beetles kill and are the direct cause of the death of more timber than is caused directly by forest fires. The control of *Dendroctonuns* beetles would reduce to a very great extent the cost of the control or prevention of forest fires, while, on the other hand, forest fires contribute very little to the spread of destructive outbreaks of tree-killing insects."

Gipsy Moth Investigations.—A detailed study of the food-plants of the caterpillars has been made in connection with the control of the Gipsy Moth in forests, where the measures adopted under more intensive conditions, *i.e.*, spraying, grease-banding, creosoting egg-masses, introduction of parasites, etc., are prohibited. It has been found that the constituent species of a mixed forest can be grouped into classes according to their susceptibility to attack by the Gipsy Moth. The dominant species in the forest and usually those of highest commercial value prove to be most liable

to attack, but some species are immune during the early larval stages and thus suggest a possible method of control. The Bureau of Entomology in co-operation with the Forest Service has established 29 sample plots in selected forests, and thinned them in such a manner as to put them in the best sylvicultural condition to resist defoliation. The results in certain types of mixture are already noticeable in a marked decrease of the pest.

NOTE ON THE EFFECT OF AGE ON THE CATECHIN CONTENT OF THE WOOD OF *ACACIA CATECHU.*

BY PURAN SINGH, F.C.S.

In a short preliminary note on the suitability of the dead wood of *Acacia Catechu* for Katha-making (*Indian Forester*—Vol. XXXVIII, 1912, pp. 154—156), it has been stated that it is not the actual death of the tree but "weathering" which adversely affects the Catechin content of the heartwood; in other words, this is due to slow and gradual oxidation and anhydration. This enquiry was continued and the effect of age on the Catechin content has been definitely determined by examining the same sample of wood after a storage of four years. A forty years old specimen of the Katha wood obtained from the Museum of the Forest College, Dehra Dun, has also been examined by way of confirmation of the results obtained in the first case. The results of the two samples examined are tabulated below :—

Serial No.	Description.	Moisture per cent.	Catechin per cent.	Methyl alcohol extract per cent.	Aqueous extract per cent.	REMARKS.
1	*Acacia Catechu* heartwood from Siwaliks, girth about 4 ft., obtained and examined in 1907.	Fresh ... 25·40 Air-dried... 7·50	8·78 10·90	11·04 13·70	17·58 21·80	The residue of the alcoholic extract left after evaporation of the alcohol was soluble in cold water, the insoluble portion being wholly Catechin crystals.

Serial No.	Description.	Moisture per cent.	Catechin per cent.	Methyl alcohol extract per cent.	Aqueous extract per cent.	REMARKS
2	*Acacia Catechu* heartwood from Siwaliks, girth about 4 ft., obtained and examined in 1911.	10·86	...	9·31	8·54	The residue of the alcoholic extract left after evaporation of the alcohol was wholly insoluble in cold water, the insoluble portion being Catechu reds with no trace of Catechin
3	A forty years old specimen of Katha wood from Garhwal Kumaon, from the Museum of the Forest College, Dehra Dun, examined in 1911	8·11	...	5·44	10·00	The residue of the alcoholic extract left after evaporation of the alcohol was almost wholly insoluble in cold water, the insoluble portion being Catechu reds with no trace of Catechin

It is remarkable that the wood loses the whole of its Catechin content after four years, and there is a great change in the nature of the alcoholic extract. Generally, the residue of the alcoholic extract of the good Katha wood, which mostly consists of Catechin and Catechu tannic acid, obtained by evaporating the extract over a water-bath gives with cold water a pale-yellow tan liquor with pinkish-white crystals of Catechin in suspension. But in the case of old specimens, the alcoholic extract is of a dirty red colour and the residue left after evaporation of the alcohol is mostly insoluble in cold water, showing not only the absence of Catechin but the presence of a good deal of the oxidation products of Catechu tannic acid known as "Catechu reds." The insolubles in cold water were also examined microscopically and not a trace of Catechin could be found. In case of good

Katha wood, the approximate percentage of tannin in the wood is found by deducting the Catechin from the total residue of the alcoholic extract. It was noticed that in case of old woods, the alcoholic extract had a very small amount of soluble tannin, most of it being cold water insolubles, "Catechu reds." In the case of the forty years old specimen, the alcoholic extract has decreased to 5 per cent. and the aqueous extract to 10 per cent. Garhwal woods are famous for Katha-making, and taking 20 per cent. as the general percentage of aqueous extract, it is curious that after forty years, it goes down to 10 per cent.

These results go to confirm the conclusion arrived at in the preliminary paper already mentioned that this loss is due to slow and gradual oxidation and anhydration of Catechin and Catechu tannic acid, Catechin first changing into Catechu tannic acid and the latter in turn passing into insoluble oxidation products.

In this connection, it may be interesting to record that Katha woods drawn from the sandy plains of Rajputana also show no Catechin. Two samples of Katha woods from Bikaneer State were examined for the State with the following results:—

Serial No.	Description.	Moisture per cent.	Catechin per cent.	Methyl alcoholic extract per cent.	Aqueous extract per cent.
1	A sample of wood from a typical tree of *Acacia Catechu* growing on the sandy slopes of sand-hills on the eastern part of the Bikaneer State, received from Rai Bahadur Sadhu Singh, Forest Officer, Bikaneer, and examined in 1910.	11·26	...	2·41	9.18
2	Another sample of Bikaneer wood, received and examined in 1910.	12·76	...	2·16	5·42

The *Acacia Catechu* does not seem to grow well in Bikaneer. The first specimen was barely 9 inches in girth and its colour was black instead of the usual reddish brown. The second sample

from the same State was asked for and examined to see if absence of Catechin and the low value for alcoholic and aqueous extracts were normal features of the Bikaneer Katha wood. An examination of both the samples go to prove that the Katha wood grown in Bikaneer has no Catechin and is generally poor in tannin. The results of the examination of the Bikaneer wood seem to indicate that the climatic conditions prevailing in Bikaneer are not conducive to the formation of Catechin. Owing to the extreme dryness of the climate and hot winds, it is possible the same change is brought about in Bikaneer as is done by long storage in the case of the other samples examined. At any rate, the general composition of the Bikaneer wood is similar to that of the old Katha woods.

GRASS TICKS.

In the issue for March 1915 of the *Indian Forester* I concluded a note "On Some Forest Matters" with a reference to the above-named troublesome pests in a not very serious mood. Since then I have learnt that the subject merits very serious consideration.

An officer of the Veterinary Department informed me that he was attacked by grass ticks during a shikar trip and suffered so severely and for so long that his health began to be seriously affected. Eventually X-Ray treatment was recommended and it was not till each tick bite had been subjected to this treatment that the sores and irritation disappeared.

In this connection the following extract from the issue of *Knowledge* for July 1915 is interesting :—

"The life-history of ticks has been described by several writers. They pair on their host. The female swells to an enormous size, and when ready to deposit her ova she leaves the host on which she has been living and drops to the ground. Here, either on the surface of the ground or just below it, she deposits large numbers of eggs in clusters. It has been computed that a female tick will deposit from 10,000 to 20,000 eggs. They issue in elongated clusters from the front of the tick. The eggs are somewhat

oval in shape, and usually of a dark brown colour. They are coated with a viscous substance for protection. How long the eggs lie before hatching is governed by the temperature, environments, and the species to which the eggs belong. The time varies from a few days to a month. Curtice says the Texas-fever tick takes from three to four weeks. The young ticks, when first born, are hexapod, having only six legs, the same as we find with most other mites. They are of a light colour, which gradually darkens to a rich brown tint, when they are known as "seed ticks." They ascend the grass and bushes and wait for some warm-blooded animal to come along, so that they can attach themselves to it. In the case of the species known as blue ticks, Dixon and Spreull say that the larvæ, on hatching, ascend the grass or bush, and as many as 2,250 larvæ have been counted on the top of a single blade of grass; also that by day and night, through wind, rain, and light frost, they remain at their post waiting for something to come along, and specimens have been found still living, after three months of this weary vigil, showing how well adapted they must be to go without food for so long a time. They do not all secure a host, those that do begin business at once. The others die of starvation. Those that are fortunate enough to secure a host grow very rapidly, and in a few days are ready to undergo their next change. Most species drop as the mite from their host and hide in the earth or grass, change their skin, and emerge as the nymph. At this stage it has eight legs, but is without the developed genital area we find in the adult. It now again ascends the grass and bushes and goes through the waiting period for another host. After a few more days of this parasitic life it again drops to the earth, changes its skin, emerges as an adult, and becomes parasitic again. Its life-history is supposed to last from two to three months. Both changes in the blue tick take place on their host; the female only drops to the ground when ready to deposit its ova.

"If there is one super-family of the *Acarina* which should receive more attention than another in all countries it is that of the ticks. They can be found free, but more often they are found

parasitic on mammals, birds, and reptiles. The damage that they can do their host, not so much by their blood-sucking as by conveying disease from one animal to another, is well known. A number of diseases of domestic animals is due to blood parasites which have been conveyed by ticks from an infected host to a previously healthy one."

Further study of the blood-sucking ticks is greatly needed and Forest Officers are in a good position to assist. Mr. R. S. Hirst at the British Museum (Natural History Section, Cromwell Road, South Kensington), is making a special study of these creatures. He will welcome any specimens, which may be sent direct to him or through me. The ticks should be placed in small glass tubes in either alcohol, methylated spirits or formalin. The vessel should contain a small slip of paper with the locality, date, elevation and name of collector written on it *in pencil*.

Any other useful information may be sent on a separate sheet, but care should be taken that this information can be applied to the correct specimen, if more than one kind is sent. For this purpose only one kind should be placed in each tube and the slip inside the tube should be numbered.

C. E. C. FISCHER, I.F.S.

The Forest Zoologist at Dehra Dun will be glad to send tubes and spirit to any one wishing to collect ticks for the British Museum.—HON. ED

A NOTE ON ROAD ALIGNMENT.

BY J. W. A. GRIEVE, I.F.S.

In practically all the books and Manuals that have been produced on forests roads, the following essentials are laid down :—

To align a road from A to B, it is useless to start blindly, but the officer making the alignment should go over his whole line and select his obligatory points as a preliminary, and then join them up by aligning on the most suitable grades obtainable.

Under certain conditions, this becomes a council of perfection and is in practice an impossi bility. Such conditions obtain on

ground consisting of irregular low ridges and hills covered with dense evergreen undergrowth: and where the bottoms of the valleys consist of soft ground, to carry a road over which would entail a heavy expenditure in banking and metalling, and with every probability of an unsatisfactory result, and where the aligner has no very deep gorges or steep ridges as guiding marks. Under these conditions he has no alternative but to go ahead blindly, and trust to luck.

The forests of the Andamans are cases in point, and being uninhabited, the roadmaker is at a further disadvantage in having no local knowledge or native footpaths to help him. No doubt in parts of Burma and other places, similar conditions are found. After a certain amount of experience in road-making under varying conditions, the following procedure has been adopted here with good results :—

To lay a road from A to B.

(*i*) Take the compass bearing between A and B from the map, and lay it on the ground. This involves little labour, and if the first 50 yards are laid down with by compass, any ordinary forest guard can carry on the line with sufficient accuracy by putting three pegs out in line in the usual way. If there happens to be any outstanding feature forming an obligatory point between A and B, then one bearing must be taken to it, and another bearing thence to the end of the line.

(*ii*) Then take the ghat tracer or other instrument and commence aligning. The value of the compass bearing on the ground at once becomes apparent: for, instead of going blindly all the time, as would be the case without it, the aligner always knows in which direction his line should tend in order to get the shortest length of road; by means of the bearing of whose position on his right or left, he is always aware,

Abnormal Antlers of the Cheetul (*Cervus axis.*)

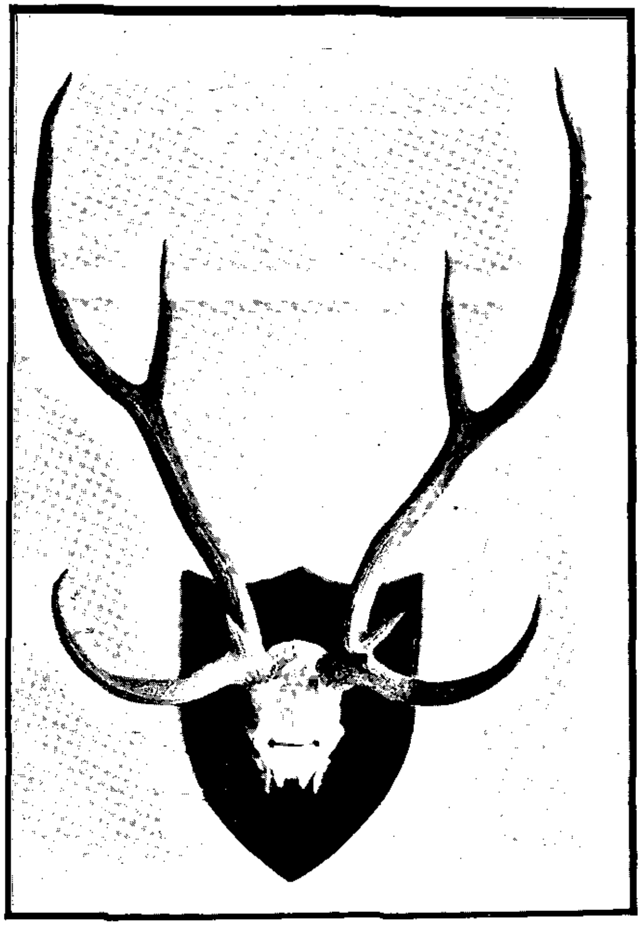


Fig. 1.

Fig 2.

Photo-engraved & printed at the Photo.-Mechl. & Litho Dept., Thomason College, Roorkee.

(iii) At the same time, or as soon after the completion of the alignment as possible, make a plane-table map of the line, marking the chainage at suitable intervals on the ground. It is often possible to straighten considerably many curves that have crept in by reason of the aligner's inability to see more than 15 or 20 yards ahead of him. It is then a small matter to correct the map thus made, and put the correct alignment straight on to the permanent map record.

I send the above note for what it is worth, because I have not seen the point dealt with in any text-book, and much time is frequently lost in the cutting of numerous lines which have subsequently to be scrapped as unsuitable.

ABNORMAL ANTLERS OF THE CHEETUL (*CERVUS AXIS*).

BY R. ST. G. BURKE, I.F.S.

The cheetul presents, in its antlers, so many variations from the normal clean six-pointer that a collection of abnormal antlers, and speculation as to the causes for their production, seems to me to be of some interest. I have, therefore, prepared this article, with its accompanying photographs (copies of which latter were, however, first published in *The Field* of July 3rd, 1915), in the hopes that it may be of sufficient interest to readers of *The Indian Forester* to elicit criticisms, and descriptions of similar abnormalities in the collections of others.

The chief variation from type consists of supplementary points at the junction of the main stem and the brow antler; less common, but by no means rare, being points along the brow antler. In only one instance have I come across such points along the main stem well clear of the brow antler, and this is shown in Fig. 3. This latter is, however, presumably only a variation of the main idea of these supplementary points.

My experience in the U. P., covering the Kheri, Gonda, Gorakhpur, and Lansdowne divisions, has been that these

uspplementary points occur in at least 50 per cent. of stags, so that it seems clear that freak causes must be dismissed in searching for a reason for this kind of abnormality. Moreover, the supplementary points are in some cases of so symmetrical a nature that such reasons as injury while in velvet must of necessity be ruled out of court as being too improbable to be entertained. Take for instance Fig. 2. This is a fine ten-pointer, and the extra points are almost completely symmetrical in every way. It seems impossible to imagine an injury—or other freak cause—operating in such a way as to produce exactly the same growth on both brow antlers.

What then is the reason for such departures from the normal? I have heard it suggested that they are a throw-back to some remote ancestor which possessed antlers of the red deer type. Has any one any reasons for or against this theory, or can any one suggest any other reason? Possibly the question may already have been quite satisfactorily settled: if so, I should be grateful for enlightenment.

2. Apart from the above type of abnormality one comes across other cases which are interesting in themselves as freaks, but which do not appear to have any origin other than an individual one. As regards reasons causing freaks, pure and simple, it is well known that an imperfect testicle, or injury to the horn when in velvet, sometimes produces curious results, while it is quite conceivable that old age may have something to do with the production of freak horns in certain cases, and I have also heard it suggested that the growing horn may sometimes get diseased (*e.g.*, itch) with similar results. Has any one any other reasons to suggest?

Figs. 4—10 are all interesting cases of what I class as freaks, pure and simple, and I should be grateful for criticisms or suggestions as to their origin.

Fig. 4 represents a distinctly deformed head, the right horn measuring only 21½" to the 25" of the left, the chief growing energy of the right horn being apparently taken up with producing the unusually long extra point from the junction of the main stem and the brow antler. Owing to the length of this extra

Abnormal Antlers of the Cheetul *(Cervus axis)*.

Fig. 3.

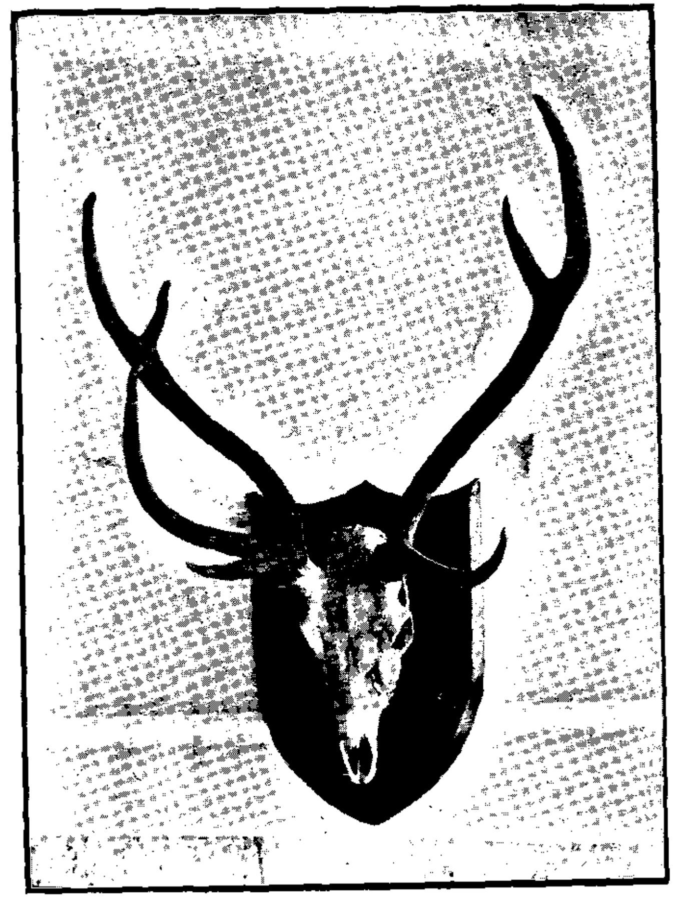


Fig. 4.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Abnormal Antlers of the Cheetul (*Cervus axis*).

Fig. 5.

Fig. 6.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Abnormal Antlers of the Cheetul *(Cervus axis)*.

Fig. 7.

Fig. 8.

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

point, developed as it is almost into a supplementary branch, I am inclined to class this head as a freak rather than as an exaggerated instance of the usual growth of such extra points, and to put the abnormality down either to old age or to a defective testicle. Unfortunately I did not examine this latter point when the animal was shot, but the lop-sided character of the horn growth would seem to give some colour to the theory. On the other hand, the animal was obviously a very old stag (the insides and tops of its ears, for instance, were silvery white), and the miserable horn measurement would seem to indicate a deteriorating head, which might also be the cause of the abnormality.

Fig. 5 shows a stag with the two upper points on the left antler of the same length. From the fact that the branch which should be the longer is markedly crooked I should say that this abnormality was undoubtedly due to injury when in velvet.

Fig. 6 shows a stag with three well-developed points on the top of the right antler—a curious abnormality for which I am unable to account satisfactorily. The general appearance of the horn at this point and the method of growth and nice development of the extra branch would appear to preclude injury as the cause.

Figs. 7 and 8 show a most extraordinary horn growth. It is rather difficult to arrive at a fair total of points on this head, but counting downward-pointing points, it may, I think, be said that it is at least a fourteen-pointer. The left antler carries a thick and well-developed supplementary branch 21″ long, which starts just above the angle between the main stem and the brow antler. Between this supplementary branch and the main stem there is wedged a thick mass of irregular growth, which may have originated in the lodging of some foreign matter in the angle, but which has every appearance of being a horny growth and which carried on it the remains of velvet when the animal was shot, as it was then not quite clear of velvet though quite pucca. In addition to this the left brow antler carries a well-developed growth in the shape of a T, the right brow antler carries an inverted hook in addition to two ordinary extra points round about the angle, and the extra branch on the left antler has two curious excrescences

near the top. The horn is lop-sided enough to be due to an imperfect testicle, but neither that reason, nor any injury, would seem to be sufficient to account for the T, or the inverted hook, or the two excrescences on the supplementary branch. The best explanation would seem to be the lodging of foreign matter in the left antler combined with an attack of itch (if this latter can be accepted as a possible cause in any case at all).

Figs. 9 and 10 show another extraordinary head. The animal has dispensed entirely with the upper side points on both horns, but has a curious downward-pointing point at the back of the left antler which is shown in the side view. Both main stems bend backwards from the burr instead of coming more or less straight out, both are hollow thereabouts, and the right antler is also deformed in shape at this point. The right brow antler has been broken off. The head is even more unsymmetrical than the photographs indicate. The animal was a very old one and the horns have the appearance of having been worn for several years, so that I think it may fairly be assumed that old age had, at any rate, a hand in the production of this abnormality.

3. The only other Figure shown which has not been mentioned is No. 1. This is given as a good instance of the ordinary type of antler with extra points at the junction of the main stem and brow antler. It is an eleven-pointer, though two of the points (one on each horn) do not show up well on the photograph.

Head No. 1 was obtained in Kheri, Nos. 2, 3, 5, 6 in Gorakhpur, and Nos. 4, 7, 9 in Lansdowne.

EXTRACTS.

PRICKLY PEARS.

With reference to an article in our issue of April last Mr. A. K. Bovill writes :—

On page 829 of your *Cyprus Journal* I see it stated that the prickly pear leaves are stated to be an excellent food for milch cows and pigs. I am afraid that this statement may give cause of trouble unless it is further explained that if fed to animals raw the spines may seriously inconvenience the animals eating them : that the leaves should be well boiled so as to soften the spines. They then become excellent food for cows and pigs.

Prickly Pear Feeding Experiments. Horn, E. W. Department of Agriculture, Bombay, Bulletin 58 of 1913, Bombay, 1914.

In order to determine the possibility of using prickly pear (Opuntia) as fodder during times of famine, some feeding experiments were carried out at the Government Civil Dairy, Kirdee. Six bullocks were fed with a mixture of 100 parts of prickly pear to 6 parts of cotton seed at the rate of 72 lbs. per 1,000 lbs. live weight per day for six months. The prickly pear was prepared for consumption by first burning off the spines over a stove and then cutting the slabs into small pieces by means of a chaff cutter or a

chopper : the burning was accomplished at various rates, from 30 to 100 lbs. per hour according to the stove used.

* * * * * *

The animals were in very poor condition at the beginning of the trial and all improved markedly as time went on ; four out of the six took the ration readily from the first, while the other two were longer in getting accustomed to it. The fodder was also fed successfully to a mixed dairy herd of cows and buffaloes in quantities up to 14 lbs. per head per day and to young stock. Altogether, as a result of the trials, it may be said that the mixture of prickly pear and cotton seed used will not only support life but enable an animal to regain condition even after it has become very poor from semi-starvation.—[*Monthly Bulletin of Agricultural Intelligence and Plant Diseases,* March 1915.]—[*The Cyprus Journal.*]

A reference is invited to an extract on the same subject in our September issue.—HON. ED.

THE UTILITY OF WOOD-PULP.

In a Press interview appearing in the London newspapers of August 21st, "a leading authority on the subject" is quoted as saying that wood-pulp is one of the wonders of modern commerce, and it really seems as though the list of articles which can be manufactured from it is inexhaustible. Everybody knows that but for wood-pulp the newspapers could not obtain sufficient supplies of paper for their needs, and now it seems likely to make itself as indispensable in other branches of industry. Cigarette and cigar holders, fancy combs, buttons, handles for such things as umbrellas and sticks, all kinds of insulating materials for electrical fittings, films, and innumerable other articles are all made from the same pulp, as are also blouses, stockings, and other articles of attire. Tens of thousands of workpeople are engaged in industries which depend largely upon wood-pulp for their raw material, and the turnover yearly in this country alone amounts to millions of pounds. At the present time, it was stated, the demand upon the factories for many of the articles was so great that they were unable to cope with it

and were booked up for months ahead.—[*The Pharmaceutical Journal.*]

EDIBLE WOOD.

The scarcity of food and animal fodder which the war has caused has compelled the Germans to look about for substitutes, among which wood naturally presents itself. The idea of using wood as food is not new. In famines and sieges the supply of flour has often been eked out by the addition of ground bark and sawdust. In the great famine of 1816 and 1817 the Chancellor of a German University experimented with wood, and published an article on the art of making bread of wood.

Professor Haberlandt has recently made a thorough study of the food value of wood. He has found, according to Prometheus, that the wood of trees constitutes, to some extent, a reserve supply of material, and that it contains, especially in winter, large quantities of sugar, starch and oil, and small quantities of albumen. These food-stuffs are found only in living wood, *i.e.*, in the sapwood, twigs and branches, not in the heartwood of the trunk. Soft woods such as pine, birch and linden, contain much oil, but very little starch, while hard woods contain a large amount of starch, from $\frac{1}{8}$ to $\frac{1}{4}$ of their bulk, consisting of starch-yielding tissue.

It is evident that the eating of wood introduces into the stomach a great quantity of indigestible matter, from which the digestive organs can extract the nutriment only if the cells of the wood have been broken by very fine grinding. Pine and spruce are too resinous for food, and oak and willow contain too much tannin. Maple, poplar, elm, linden and birch appear to be the woods which are most suitable for food. It is too early to decide to what extent wood can be used as food. Of course it would be absurd to make bread entirely of wood meal, but a small proportion of this might be added to the flour. It seems quite possible, however, that wood may be utilised as fodder for animals, if the cost of grinding the wood to the very fine condition which is necessary for digestion is not too great in proportion to the food value.—[*The Scientific American.*]